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Vol. 97 JUNE, 1925 No. 6

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Price $3.00 per Annum in Advance. Foreign Postage, 25 Cents Extra.

Single Numbers, 30 Cents. Back Numbers, 50 Cents.

Entered as Second-Class Matter at the Post Office at Philadelphia, Pa., Under the Act of March 3, 1879.

Acceptance for Mailing at Special Rate of Postage Provided for in Section 1103, Act of October 3, 1917. Authorized February 15, 1920.

PUBLISHED MONTHLY BY THE

Philadelphia College of Pharmacy and Science

145 North Tenth Street, Philadelphia

American Journal of Pharmacy

ESTABLISHED IN 1825

Four preliminary numbers were published at different times until in 1829, when the publication of the regular volumes began. Since then the publication has been uninterrupted. During the period from 1829 to 1852 four numbers were published annually, except in 1847, when five numbers were published. From 1853 to 1870 six numbers were published. Since this time twelve numbers have been published annually.

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THE AMERICAN
JOURNAL OF PHARMACY

Vol. 97. June, 1925. No. 6.

EDITORIAL

TOBACCO AS A MEDIUM FOR THE ADMINISTRATION OF POTENT DRUGS.

Lickint devotes considerable space to an article on this subject, based on an extensive study of the literature, which is quite voluminous. The article appears in the *Ber. Deutsch. Pharm. Gesell.* (1925, *35*, 181). American chemists who have been working in the analysis of foods and drugs are quite familiar with the newspaper stories of poisonous cigarettes as the cause of the evil effects of those "coffin nails," opium and arsenic being chiefly alleged. The present writer has been for about a half century trying to find an authentic instance of the occurrence of either of these drugs in manufactured tobacco without avail. As with intoxicating beverages there is always the shibboleth that if the articles could be obtained "pure" the use of them would not be attended with evil effects. The truth is that the injurious ingredient in fermented beverages is the alcohol and the injurious ingredient in tobacco is the nicotin or its products of decomposition.

Lickint's paper is not concerned with such adulterations, but with the practice, presumably more common on the Continent of Europe than with us, of using smoking as a means of administering disagreeable medicines. Tobacco, like any other article prepared on the large scale and used by human beings may be the carrier of dangerous substances for instance, lead, but this is a matter of public hygiene. Arsenic we are told has been administered in a specially prepared cigarette and La Rue reported in 1866 in the *Boston Med. and Surg. Jour.* the good result obtained with a tuberculous patient who inhaled from 1½ to 4½ grains weekly for some time without unfavorable symptoms. In a case in which a priest was charged with murder of one of his colleagues by means of cigars imbued with arsenous acid, Bunsen found that a Bremen cigar weighing

close to 80 grains would take up about 2½ grains of arsenic. It was decided that this is a poisonous dose. The opinion that two grains of arsenous acid may be fatal to an adult rests upon a case reported many years ago in an English journal. Works on toxicology have carried this statement for many years, but Witthaus examined the original report and it is unsafe as a guide in this matter, for the exact amount of arsenic taken by the patient is not known and there were concomitant conditions that may have contributed materially to the fatal result. One observer states that the introduction of finely powdered arsenic into a cigar may add danger by this being absorbed through a broken mucous surface, but it seems impossible that any serious action could thus occur except in long continued use when slow poisoning might be developed. However, it is pointed out by another expert that the garlic-like odor characteristic of a reduced arsenic and quite noticeable, would warn a smoker against any such admixture. Arsenic, by the way, may be found in minute amount in tobacco. Hydrogen cyanide may be impregnated into tobacco. If freshly used it may produce fatal results, but it is pointed out that the characteristic odor would betray an unusual addition, and in a few hours the compound would be volatilized. Cyanogen compounds are, indeed, produced in the smoking of tobacco by reaction of the protein nitrogen with alkaline materials. An odor recalling that of hydrogen cyanide is often detected in ashing organic matters containing alkaline salts. A case of slow poisoning by lead from the long use of a snuff which was packed in lead foil instead of tin foil was reported. This also is a matter of public hygiene rather than pharmacology. Admixture of chloral hydrate with snuff has been reported, and one authority advises such addition, claiming that the drug is an antidote to nicotin.

A more imminent issue is the matter of addition of opium to tobacco. As noted above, the occurrence of opium or its alkaloids in smoking tobacco has been practically unreported in this country, but it seems that just after the close of the late war, opium cigarettes were brought into Germany from England and found a wide use. Utz, who reviewed the literature on this subject, found by trial that in slow smoking of a cigarette to which he added 20 milligrams (about 1/3 grain) only traces of the alkaloid were emitted and in quick smoking, none. Thoms reported to the German Pharmaceutical Society (*Ber. D. Pharm. Gesell.*, 1920, *30*, 366), that in some suspected

cigarettes he had found a substance derived from nicotin or its allies, that gave some of the reactions for morphin, which fact may account for some of the stories of opium adulteration of tobacco. No morphin was found when the complete series of tests was made. The alleged strong soporific action of these articles Thoms ascribes to high nicotin content. The author of the essay under consideration seems to lend some faith to the stories of persons stupified by cigars for evil purposes, but in this as in the much more common allegation of "doped" liquor, one must always be on guard for pretense, bearing in mind always the maxim of the old Roman lawyers, *"Non omnes dormiunt, quae clausos habent oculos,"* "Not all are sleeping who have closed eyes."

As a final topic, Lickint speaks of the use of stramonium leaves either alone or with tobacco as a remedy for asthma. This has been long in use, but presumably in these days with a much larger knowledge of the causes of asthma this expectant treatment has found less application.

HENRY LEFFMANN.

THE NEW PHARMACOPŒIA.

The Board of Trustees of the United States Pharmacopœial Convention has selected January 1, 1926, as the date on which the new Pharmacopœia becomes official. It cannot be definitely stated just when the book will be on sale, but the Trustees are confident that the new revision will be available in ample time to supply the schools of pharmacy with the new standard for use during the session of 1925-26. Just as soon as the U. S. P. X is available, announcement will be made by the sales agent, J. B. Lippincott Company, of Philadelphia.

Arrangements are being made to place on the market throughout the entire United States, on a date to be specified, 30,000 buckram bound copies of the new book. The retail price is $4.00 per copy. It is advisable for schools and other dealers handling the book in quantity to place advance orders with the J. B. Lippincott Company without delay.

The price of the U. S. P. IX, which has been the official standard for the past ten years, has been reduced to $2.00 per copy by the Board of Trustees. The book may be purchased direct from P.

Blakiston's Son & Company, Philadelphia. The reduction in price has been made in order to encourage pharmacists, schools and libraries in keeping sets of the Pharmacopœia for official use until January 1, and future use as works of reference. More than 80,000 copies of the U. S. P. IX have been sold.

The Spanish Translation of the new Pharmacopœia is being made for use in South and Central America and other Spanish-speaking countries of the western world. The Spanish Translation of the U. S. P. VIII and the U. S. P. IX met with a large demand.

The Board of Trustees in co-operation with the American Pharmaceutical Association is arranging to publish an Abstract of Comments on the Pharmacopœia. This is very desirable on account of the United States Government having discontinued such a series of books.

The Board of Trustees and the Committee on Revision will be represented at the International Conference for the Unification of Formulas for Potent Remedies, which meets in Europe, this fall, by Dr. A. G. Du Mez, of the United States Department of Hygiene. The U. S. P. was the first Pharmacopœia to recognize the standards which have already been adopted by the International Conference.

The Joseph P. Remington Memorial, which has been under consideration by the Board of Trustees since the death of Professor Remington, is now assuming definite form. A fund will be set apart so that the interest on the same can be used for research work on subjects of Pharmacopœial interest and value. The American Pharmaceutical Association will be the trustee of the fund and the Chairman of the Committee on Revision of the U. S. P. will be Chairman of a standing committee to be named by the Board of Trustees for the purpose of determining the subjects of research work and to recommend to the trustees the persons granted awards from the Remington Memorial Fund.

HENRY M. WHELPLEY.

ORIGINAL ARTICLES

WHAT SHALL I EAT?*

By Horatio C. Wood, Jr., M. D.

Professor of Materia Medica, Philadelphia College of Pharmacy and Science.

Before man had invented the arts of agriculture his food supply, dependent largely on the chance result of the hunt, was so uncertain and irregular that he lived almost continuously on the border line of hunger. He could not afford to be concerned about the quality of his nourishment, it required his utmost endeavor to obtain sufficient quantity to meet his absolute needs. There are parts of the world even today where this same condition holds, where it takes only a slight disturbance of the economic balance to drive thousands to eating leaves and filth in the hope of temporarily assuaging the pangs of starvation. But we in America have long enjoyed not only an abundance but even a superfluity of food, so that we are able to pick and choose among the various forms of nourishment. As a matter of fact the American people suffer more from the results of overeating than from lack of nourishment. That the character and amount of food has a profound influence upon the health of the individual has been known from the time, at least, of Hippocrates. Today our minds, and our news-stands, are flooded with a most bewildering variety of all sorts of bizarre regimens by a host of cranks and quacks each advocating vociferously some dietetic fad as the panacea for all human ills. We are alternately urged to eat nothing but raw meat or no meat at all; to live on grass and bran like the cow or on fruits and nuts like the monkey. In the face of such an array of contradictory advice it seemed to me that it might be of interest to briefly review some of the established facts underlying the science of nutrition.

An engine derives its power in the last analysis from the burning—or as the chemist would express it from the oxidation—of carbon, which is found alike in coal, wood or oil. The human body is like the steam engine in that it derives the energy or the

*One of a Series of Popular Lectures given at the Philadelphia College of Pharmacy and Science, 1924-25 Season.

force by which we live and move from the oxidation of carbon. What the fuel is to the steam engine, that is food to the body.

Those of you who have had some experience with automobiles know that after a while they begin to wear out, and first one little thing and then another has to be repaired or replaced. The same is true of the body, parts are constantly being injured or worn, repair and replacement must go on practically continuously. The material for the repair of our bodies must also come from our victuals. We therefore require two kinds of food supplies, one containing carbon from which we derive heat and energy, and the other containing those materials necessary for the reparatory processes. I shall call these two classes fuel foods and body builders.

The fuel foods are carbonaceous and can be sub-divided into three groups—the carbohydrates, including starch and sugar, the fats and the proteins. I want to emphasize at this point a very important fact, that very few of our eatables belong exclusively to any one of these three classes. They are nearly all mixtures. Everyone knows, for example, that milk is a complete food; it must therefore contain sugar, fat, protein, and minerals. Not everyone realizes, however, that bread also contains all three kinds of nourishment, and that beets, peas, chocolate, carrots, pumpkins, and many other common articles contain all of these necessary elements. There is, however, a great difference in the proportion of one or the other, thus bread contains very little fat but a very large amount of starch. On the other hand, chocolate is very rich in fat, peas contain relatively large quantities of proteins.

TABLE I. CLASSIFICATION OF FOODS.

Fuel Foods			*Body Builders*		
Carbohydrates	*Fats*	*Proteins*	*Mineral*	*Vitamines*	*Proteins*
Sugar	Butter	Milk	Milk	Milk	Milk
Bread	Meats	Meat	Water	Orange	Meat
Cereals	Eggs	Eggs	Green	Tomato	Eggs
Potato	Cheese	Cheese	Vegetables	Cabbage	Cheese
Fruits	Nuts			Etc.	

There is also great difference in the proportion of total nutritious substances. One good slice of bread contains as much nourishment as one-half pound of carrots, and one would have to eat

about twenty pounds a day of such food as celery to get the required amount of nourishment.

We measure cloth by the yard, liquids by the quart and nails by the pound. In the same way we measure the fuel value of our victuals in terms of "calories." It would serve no useful purpose for the present discussion to give the scientific definition of the word calorie; I can perhaps convey an idea of the meaning of the word by saying that the ordinary adult requires from 2000 to 3500 calories a day according to various conditions I shall mention later. When we wish to speak of a food quantitatively we say that, for example, a man should eat so many calories of this or that food.

Lists showing the energy value of various foodstuffs have been frequently published and are available in numerous works treating of dietetics. It does not seem necessary for the present purpose to repeat these *in extenso,* but it might be instructive to select a few common and typical foods in order to convey a general idea of the amounts required. Conveniently, foods may be arranged into three groups from the standpoint of their nutritive value, highly concentrated foods, intermediate, and those but slightly nutritious. Among the first group would be included meats, fish, eggs, bread, cheese, nuts, etc., the second group would include milk, potatoes, peas, lima beans and most of the cereals. The foods whose caloric value is relatively low include generally the green vegetables such as string beans, lettuce, onions, spinach, tomatoes, cabbage and the like. An idea of the relative nutritiousness of some of these can be obtained from the accompanying diagram. To furnish 2400 calories which we may take as a fair daily requirement for the city dweller, would necessitate about 1½ pounds of roast beef, three pounds of bread, 3½ quarts of milk or 4½ pounds of fresh peas. It will be noted what very large quantities of green vegetables are required.

There is another factor which must be considered in this problem. Not only must our food furnish a total of some 2400 calories a day but about 400 of these ought to be in the form of protein in order to provide necessary repair material. From this point of view it will be noted that the green vegetables fare still worse as most of their food value is carbohydrate. The sixteen pounds of cabbage required to furnish 2400 calories would furnish only about 320 calories in the form of protein.

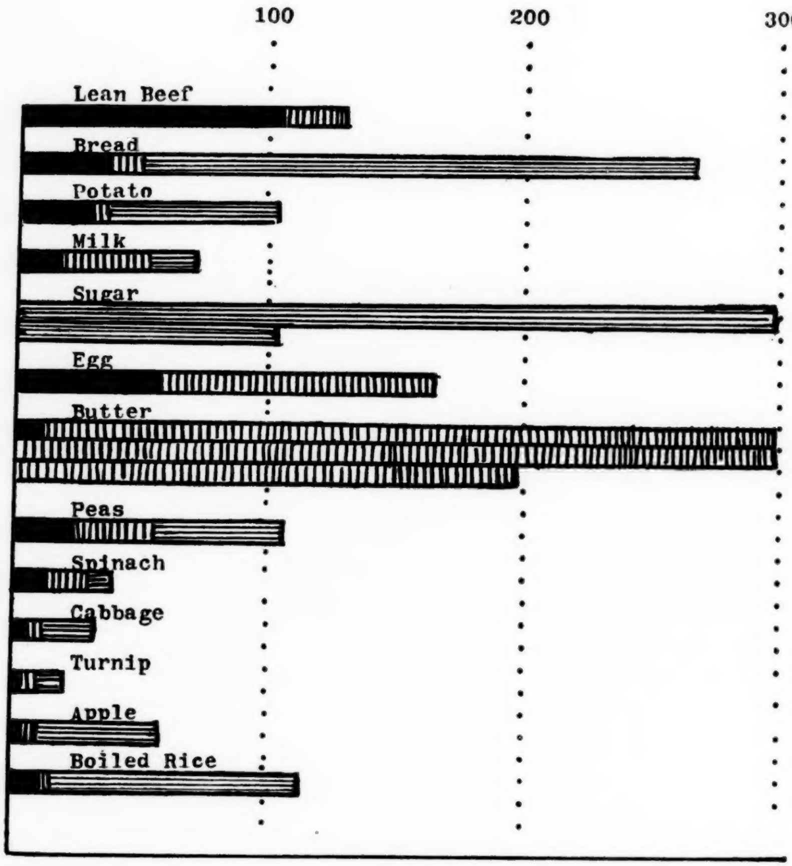

Diagram to Show the Caloric Value of Certain Food-stuffs.

The columns represent the calories in 100 Gm.

TABLE 2. TO SHOW THE NUTRITIVE VALUE OF ORDINARY PORTIONS OF SOME FOODS.

	Helping	*Weight*	*Value*
Roast Beef	1 slice	1½ ozs.	125 calories
Potato	1 large	3 "	100 "
Spinach	2 tablespoons	3 "	50 "
Cheese	1 cub. inch	½ oz.	60 "
Milk	1 glass	6 ozs.	120 "
Bread	1 thick slice	1½ "	125 "
Shredded Wheat	1 biscuit	1 oz.	100 "
Egg	1 large	2 ozs.	95 "
Sugar	2 teaspoons	½ oz.	60 "

With this brief review of the underlying facts, we are now ready to meet the practical questions—What and How Much Shall We Eat? Any answer to be of real use must be in practical terms. It can serve no useful purpose to learn the number of calories per pound of each food, for no one is going to take his scales to the table and weigh each piece of pie and measure each bowl of soup, to say nothing of taking the time to calculate from the percentage of carbohydrates and proteins given in the table the exact amount of each class he is ingesting. To be sure there is one large restaurant company that publishes the approximate food value of their various dishes, but even this is of little practical assistance.

The Creator endowed man with an intuitive guide as to the quantity he should eat. In the natural state the appetite is a very useful indicator of the amount of food required. By "natural state" I mean for men who are living in the circumstances for which they were biologically intended. When Adam was expelled from the Garden of Eden he was told: "In the sweat of thy face shalt thou eat bread," and for a true son of Adam the appetite guide is a good one, but for the city dweller whose brow has never known the sweat of physical exercise, it is a most unreliable indicator. I knew two young men who entered the army during the war. They were approximately the same age, in their twenties, and about the same height. When they entered the army one weighed 190 pounds and the other 120; when they were mustered out of the service they weighed respectively 160 and 150. The fat man had grown thinner, the skinny man had become stouter. Both, in other words, had approached to the normal size. After the war they went back to their sedentary

occupations and today the first has gone up to 200 pounds and the other down to 120.

The most reliable and the most practical criterion is the weight of the body. If we are gaining weight it is very certain that we are assimilating more food than we are burning. The life insurance companies have determined by long experience what an individual should weigh. Their conclusions are not based merely on an average, that is by taking 1000 people of a certain height and weighing them and then averaging the total result, but it is determined by finding the death rate of people for each weight, and the figures they give represent the weight which gives the man the most probability of a long life. I am a strong advocate of the habit of regular weighing. I believe that everyone should weigh themselves at least once in two weeks and regulate their mode of living accordingly, especially as to their diet. If you are more than 10 per cent. overweight, go to bed hungry, if you are losing flesh steadily you probably need medical attention.

The amount of food and the kind of food required varies enormously with the age, size, occupation and climate. Children require proportionately much larger amounts of all kinds of food. I say proportionately, because the food requirements are by scientists gauged according to the size of the person. The bigger the automobile the more fuel it consumes, and the same thing is true of man. A little man does not require as much food as a large one. Children require large amounts of energy foods because they are so continuously active; but especially do they require abnormal quantities of the body-building foods, such as the proteins and the minerals, to furnish the material for the growing organism. Probably the two most common errors in the feeding of children are the excess of sugar and the insufficiency of green vegetables. The candy and ice-cream cone and soda water habits are injurious not merely because of the liability of acute indigestion, but chiefly because of the fact that overindulgence in sugar tends to lessen the consumption of more important body-building foods. The constant titillating of the palate by sweets begets an abnormal appetite and the child develops injurious dislikes of wholesome pabulum. The sugar being an easily combustible food, one whose energy can be quickly utilized by the body, satisfies temporarily the natural healthy craving for food, and at the same time the sweet taste tends to kill appetite. The result

of these two factors is that the child who is allowed to indulge in sweets between meals is generally "picky."

Another very important factor which should regulate our food intake is the occupation. Persons of sedentary life obviously need less fuel than those who perform continuous muscular labor. Even the most active use of the brain consumes no perceptible amount of fuel.

As our food furnishes not only the force to drive our bodies but also the heat to keep us warm, the temperature of our surroundings will vary the amount we eat. Those who live indoors need less fuel. It is this heat making quality which is the explanation of the apparent paradox that fat people need less food than thin. Their bodies are protected by a thick overcoat of fat from the rigors of the winter.

Now, just a word about the results of improper stoking of our engines; either too much or too little is injurious. The ills of undernourishment are so well known and the process of starvation so unpleasant that I do not believe it necessary to discuss that phase. But the city dweller is so likely to eat more than he needs that it will pay to stop and see what becomes of the superfluity. Excess of nourishment is stored up in the body in the form of fat which is intended as a reserve supply to tide the body over periods of starvation. A certain amount of bodily fat is very desirable. In the first place, being deposited immediately beneath the skin, it protects the body from the effects of changes in temperature. The whale and walrus can remain comfortable—although both of them are warm-blooded animals—swimming in icy water because of the thick layer of fat which lies under their skin. Moreover, the time is likely to come to any of us, when because of sickness or for some other reason, we may be temporarily unable to obtain the proper nourishment and we shall have to live off of our own fat. There is strong evidence that young people require more fat deposits than in later life. The healthy baby is, to use the common expression, fairly rolling in fat. An adult as corpulent in proportion would be a repulsive object. The statistics of life insurance companies show that the mortality among persons in early adult life, say in their twenties, is decidedly less for those who are a little above the average weight than for those who are below. It is interesting to note that in later

years the reverse becomes true; the man of middle life who is overweight has a greatly reduced expectation of life.

When a person takes in a larger amount of nourishment than is required to furnish energy required for that dav, one of two things happens, either a part of the excess is stored up in the form of fat to furnish a reserve against a time of insufficiency, or the unused oversupply may be thrown off by the excretory organs, especially the kidneys. If this performance is repeated one of two things will follow (frequently both). The first is an undue rotundity of figure and the other an excessive burden upon the eliminating organs with consequent injuries to them. If in an automobile we furnish too much gasoline—or as the technical expression is, too rich a mixture—combustion is incomplete and we get an accumulation of carbon. In the same way when the body is furnished too rich a diet the fuel is not completely burned up and there is formed certain substances, the result of this imperfect combustion, which may act as irritants to many of our organs and provoke one or another of a large variety of diseases.

I do not want to scare any of you people who eat too heartily, with a long list of all the horrible things that may afflict the fat man—he has trouble enough already—but I feel that I ought to remind you that there are a number of diseases well recognized to result from overeating and that the life insurance companies feel so strongly on the subject that they will refuse to insure a man who may be apparently healthy in every regard, merely because he is too heavy.

When we come to the problem of the proportion of each kind of food, the practical difficulties are multiplied enormously. As I have pointed out, nearly all foods combine all of the three forms of nutriment in various proportions, and a calculation of the exact amount of each would carry us into the realm of higher mathematics. Scientific exactitude in this matter fortunately, however, is of more academic than utilitarian interest.

Since the carbonaceous foods are useful only as a source of fuel, they may to a large extent replace one another. That is—a man may derive the bulk of his energy from the oxidation either of fats or of starches. In many Asiatic countries the natives use very little fatty food, living almost exclusively upon the starchy cereals. On the other hand, the Eskimo has no access to vegetable foods and takes practically none of his energy in the form of starch.

A Bengalese derives over 80 per cent. of his energy from starch. In this country on an average we obtain about 60 per cent., but among the Eskimos only 8 per cent. of their nutrition is carbohydrate. Energy, as I have already pointed out, can be derived also from the protein elements and this class of food is usually utilized to a greater or lesser extent as a mere fuel. Indeed, among such peoples as are largely carnivorous, like the Eskimos, it becomes a very important fuel.

There are several objections to the adoption of the Eskimo diet of meat and fat for us. In the first place in civilized communities it would be a very expensive form of ailment.

TABLE 3. SHOWING RELATIVE COST OF SOME COMMON FOODS.

Food	*Cal. per lb.*	*Price per lb.*	*Cost per 100 calories*
Beef	675	.45	6.7 cents
Milk	350	.18	5.1 "
Bread	1350	.08	0.6 "
Potato	490	.04	0.8 "
Cabbage	160	.15	9.0 "
Peanuts	550	.60	10.9 "
Chocolate	2700	.80	3.0 "
Eggs (each)	58	.80 (a doz.)	11.5 "
Butter	4100	.45	10.7 "

In proportion to its nutritive value, meat costs about ten times as much as bread. Moreover, man is not naturally a carnivorous animal and it is only through generations of experience that the Eskimo system has accustomed itself to these large amounts of flesh foods. Moreover the proteins have a peculiar heating property which certainly would be injurious at least during the warmer parts of our year.

Nor is the Asiatic diet, cheap as it is, to be recommended. In the colder weather we need the heating property of the protein and it is not at all unlikely that the energy of the dweller in temperate climes is largely due to the stimulating effects of the meat. A purely vegetable diet is as unnatural for man as one of purely meat. Man has neither the tearing teeth of the beasts of prey, nor was he intended to chew cud like the cow.

I am strongly persuaded of the importance of a mixed diet or perhaps I had better say—of a varied diet. This conviction is sup-

ported not alone by the fact that man's digestive apparatus is obviously not purposed for either a purely flesh or a purely vegetable diet, but especially by comparatively recent studies on food chemistry. A few years ago the generally accepted concept among physiologists of the part played by the proteins in nutrition was that they were all brought by the action of the digestive juices to one compound. Now, we know that there are at least sixteen different substances (amino acids) with which the body must be provided by the protein foods. Few, if any, of our foods contain all of these elements, and it is evident that the greater the variety in the source of protein the less is the likelihood of a lack of any one of these amino acids.

The most interesting demonstration of the desirability of a varied diet, however, is the work which is being done with those mysterious elements of our diet commonly called vitamines about which we know almost nothing, except that they are necessary.

Let me tell you two stories, one of a rice-eating people of the Asiatic tropics and the other about a Northern European cattle-raising nation. Two extraordinary diseases appeared at approximately the same time at these widely separated parts of the world. These two diseases, although not unknown before this time, became so prevalent as to make them of economic importance. The symptoms of these diseases in no way resembled one another, and the conditions of living in Scandinavia and Southern Asia are so absolutely different, that it was years before any one dreamt of a connection between these two conditions.

Beri-beri, a very painful condition, is an old tropical disease which has been known to occur now and then among the Asiatics for many years, and was generally believed to be due to some germ. About fourteen or fifteen years ago the incidence of beri-beri suddenly began to increase so rapidly as to become a matter of concern to the Asiatic governments, which led to a more careful study of the conditions under which it occurred. This increase in the disease was practically simultaneous with the introduction among this grain-eating peoples of so-called "polished rice," that is, rice which had been whitened by removal of the outer covering of the grains. As the condition did not occur among those who ate their rice in the natural state, the obvious experiment of testing the effects of the

polishings from the rice was tried, and it was found that the administration of this substance at once caused a remission of symptoms.

Economic conditions in the little Kingdom of Denmark are such as to have driven the great mass of people to the dairy industry and they have become the greatest butter producers in the world. About 1910 the demand for butter in the other countries of Europe became so great the Danish dairymen found it a money-making proposition to sell their dairy products and buy other fats to eat. Shortly after this there began to occur a series of cases of a peculiar disease of the eye, especially among children, and which in some cases went on to complete blindness. In the course of the next few years there were some 600 cases of this disease. Shortly after the beginning of the World War the export of butter from Denmark was very greatly reduced because of the activities of the German submarines. With the reduction in their foreign dairy trade there occurred a reduction in the number of cases of this new disease.

We now know that each of these diseases is caused by the lack of some element in the diet, of whose nature, however, we have no definite knowledge. To these hypothetical substances, for the purpose of convenience, has been applied the name of vitamines.

While the subject of vitamines is comparatively new and we have as yet very incomplete knowledge of their nature or role in nutrition, considerable progress has been made. It has been shown, for example, that there is no single, complete, vitamine; there are several substances of this nature which are necessary to make a satisfactory diet. So far three have been definitely established as essential and there is considerable evidence of the existence of a fourth and that others may later be discovered. As we are as yet ignorant concerning the chemical nature of these vitamines, they are usually referred to by letters of the alphabet, as vitamin A, vitamin B, etc. Vitamin A is found chiefly in certain animal fats as egg-yolk, butter and cod liver oil and also in green vegetables. Its absence leads to a peculiar disturbance of the health, the most significant symptom of which is a peculiar disease of the eye, known as xerophthalmia, and, in childen, to cessation of growth. It is not commonly deficient in American diet and may therefore be quickly passed.

Vitamin B is found abundantly in most green vegetables, to a fair extent in natural grains, but is largely removed from the latter in the process of milling and is often destroyed by cooking. It is the substance whose deficiency gives rise to the disease known as beri-

beri. A diet consisting largely of the whole grain of cereal foods will not cause beri-beri, but where these are substituted by polished rice or white bread, this disease occurs unless vitamin B is supplied from some other source.

The absence of vitamin C gives rise to that not rare disease known as scurvy. This vitamin is found in abundance in lemons, potatoes, tomatoes, and to some extent in green vegetables, milk, etc. It is easily affected by heat and in ordinary cooking of these foods vitamin C, although present in sufficient quantity, may be completely destroyed. This is the explanation of the fact known for centuries that raw foods are necessary for the prevention of scurvy.

The existence of vitamin D seems probable, but I do not think is as yet definitely proven. The common supposition is that its absence leads to that very prevalent disease of children known as rickets. There is a good deal of evidence that certain animal fats, especially milk and cod liver oil, are of value in the prevention and cure of rickets.

By experiments upon the lower animals, especially chickens and mice, with chemically purified foods, scientists have worked out the relative amounts of the different vitamins which occur in many of our common foodstuffs. A table showing these proportions has been recently broadcast through the advertising pages of our magazines by one of the large insurance companies. I reproduce it here to show in the first place the amounts of green vegetables in our dietary

TABLE 4. VITAMIN CONTENTS OF FOODS.

	A	*B*	*C*		*A*	*B*	*C*
White Bread	?	+	o	Tomatoes	++	+++	+++
Whole Cereals	+	++	?	Spinach	+++	+++	?
Meat	o	+	+	Cabbage	+	+++	+
Milk	+++	++	+	Carrots	++	++	++
Butter	+++	o	o	Lemon	?	++	+++
Eggs	++	+	+	Orange	+	++	+++
Potatoes	?	++	+	Apple	+	+	+
Oleomargarine	+	o	o	Peas	++	++	+

+ Means small amount.
++ Means moderate amount.
+++ Means large amount.
o Means none.
? Means undetermined.

and also to demonstrate that he who lives on a natural variety of foods need have little fear of vitamin deficiency. I might remark in passing that there is at present no convincing evidence that an excess of vitamin is of any service to the body. The most useful purpose that is served by the different substances advertised to contain concentrated vitamins, is to enrich the manufacturers of these preparations.

In closing this somewhat sketchy outline, may I, as a sort of summary, give a few words of practical advice.

1. Shun the fanatic. It may be assumed that those who deny the validity of the accumulated experience of humanity during centuries, are either motivated by commercial interest or infatuated with unproven theories. All of them are equally irrational.

2. Man is an omnivorous animal; that is, he is biologically constructed to live on a mixture of flesh and vegetable. He is better off with a large variety of food. If it is desirable to lessen the amount consumed, it is better to diminish the quantity of each sort of food rather than diminish the variety.

3. Form the weighing habit and regulate the amount of food you take accordingly. A person who is more than ten per cent. overweight or underweight is not in prime physical health, no matter whether or not they are conscious of any symptoms.

CHALK AND ITS CHEMICAL RELATIVES.*

By Edward J. Hughes, P. D.

Ordinarily we think of chalk as a very common substance. Some of the earliest impressions of our lives are associated with this soft, white, earthy material. Yet it may be surprising to find how much there is to be learned from a study of the substance of which the simple chalk is composed.

Chalk, limestone, marble and coral are all essentially composed of calcium carbonate, commonly called carbonate of lime. We are here to consider the various forms of calcium carbonate this evening. Our consideration will necessarily be limited and yet I feel that

*One of a Series of Popular Lectures given at the Philadelphia College of Pharmacy and Science, 1924-25 Season.

if we think about the history and the possibilities in the application of this mineral substance to the affairs of every-day life we cannot help but part with just a little better knowledge and understanding of the world in which we live.

Our present-day knowledge of the origin of calcium carbonate on the earth comes from the silent but undeniable testimony of the rocks. The rocks of the earth's crust may be divided into two great classes, namely, the igneous and the sedimentary. Igneous rocks are those that have resulted from the cooling of a molten mass or magma and sedimentary rocks are those that have resulted from the separation of a solid substance from water. A third type of rock is recognized, namely, the metamorphic, which includes those rocks that may have been of either igneous or of sedimentary origin but which have undergone changes in character because of natural agencies such as heat or pressure or perhaps both. Practically all of the calcium carbonate found on the earth is conceded to be of sedimentary origin. As a result of considerable research work carried on in behalf of the United States Geological Survey, it has been estimated that the crust of the earth is composed of about ninety-five per cent. of igneous rocks, overlaid by about five per cent. of sedimentary rocks. Of this five per cent. about one-twentieth is calcium carbonate.

Among the various forms of calcium carbonate there are sedimentary rocks of different types. Chalk, for example, is a typical organic rock made up of the shells and remains of some of the simplest living creatures. Limestone and coral are also forms of calcium carbonate that have been produced by living organisms. On the other hand, the stalactites and the stalagmites of the caves, which are largely composed of calcium carbonate, are types of sedimentary rocks that have resulted from chemical sedimentation. Because of its compact, fine-grained structure marble is considered to be a sedimentary rock that has undergone secondary changes through the probable effect of heat and pressure upon shell limestone.

Since chalk and limestone have unquestionably been deposited in the presence of water we find very convincing evidence, in the beds of these minerals that are found in nature, that a considerable area of what is dry land today was at one time submerged.

In North America the indelible record of the rocks shows that the coast at plains of the Atlantic Ocean and the Gulf of Mexico were once under water, and that the North American continent was

cut in two by a great mediterranean sea that extended from the Gulf of Mexico to the Arctic Ocean. Later on these waters were withdrawn into the abysmal basins. As a result there are large deposits of calcium carbonate in the great plains and others appearing at some distance away from the coast. These coastal deposits dip toward the sea at a low angle and are covered near the coast by more recent formations.

The period in the earth's history during which these deposits were laid down is referred to as the Cretaceous period, the word Cretaceous coming from the Latin word Creta meaning chalk. Cretaceous beds are also found in Europe, Asia, South America, Africa and Australia. The famed chalk cliffs of Dover are perhaps the outstanding examples of immense Cretaceous deposits that represent the bottom of an ocean in the ages gone by.

It is interesting to consider the various sources of calcium carbonate as it appears on the earth today. First of all there is the form that upon close examination is found to be made up of the remains of countless millions of tiny marine animals. Then there are the shells from thousands of different species of shellfish. Think of the islands, the reefs and the atolls that have been built up by vast colonies of tiny coral animals. Some of the most beautiful cave formations in the world have been produced by the slow separation of calcium carbonate from water in which it was held in solution by means of carbon dioxide. Air currents enable the carbon dioxide to escape from such solutions and calcium carbonate is deposited. It has been shown that certain vegetable organisms such as mosses, algæ, bacteria and some aquatic plants have been active in the formation of calcium carbonate by abstracting carbon dioxide from water. It has also been found that calcium carbonate is precipitated from sea water by the fermentation or the decay of the albumin present in the organic parts of aquatic animals. This gives rise to the formation of ammonium carbonate which in turn reacts with the calcium sulphate, or other calcium salts in the waters, precipitating the insoluble calcium carbonate. Two clear, well-defined, crystalline forms of calcium carbonate also occur in nature known by the names of calcite and aragonite. Fine crystals of these types have been found and they have probably formed by the slow separation of calcium carbonate from water. The finest crystals of calcite come from Ice-

land and are known as Iceland Spar. Crystals of Iceland Spar are highly valued in certain optical instruments.

Calcium carbonate is not the only mineral substance that is formed as the result of animal life. Phosphate of calcium and silica are also produced by living organisms, the former being the chief constituent of the bones of vertebrate animals and the latter making up the skeletons of the tiny diatoms and raidolarians.

The story of chalk itself is indeed a romantic one. In 1853 Lieut. Brooke of the American Navy succeeded in scooping up some mud from the bottom of the north Atlantic Ocean. He sent samples of this mud to West Point and to Berlin for examination where it was found to be composed of calcium carbonate and to consist almost entirely of the skeletons of living organisms. Most of the skeletons and the shells found in this chalky mud were observed to be identical with those found in the chalk deposits on dry land today. Later on it was found that a very large area of the floor of the Atlantic Ocean was covered with this same chalky material. It is apparent from this that the ocean is fairly teeming with life and few of us realize the importance of the ceaseless rain of the remains of tiny creatures that drift down into the depths.

In other words, the chalk deposits that are scattered over the earth represent the remains of untold millions of minute organisms that lived in large part floating on or near the surface of an ancient sea. When they died their shells sank to the ocean floor and there formed a deposit. This is just what is going on over wide areas of the ocean floor today.

Chalk is almost pure calcium carbonate although it is generally mixed with various other mineral impurities. Among the broken skeletons and shells of which it is composed are those of sea lilies, shellfish, sea urchins and many of the simplest living creatures belonging to the group of one-celled animals and included in the class of foraminifera. The remains of millions of these marine organisms may be found in a single piece of chalk.

The most extensive and conspicuous deposits of the true chalk are to be seen in the chalk cliffs of England and France on both sides of the Straits of Dover. Large beds of chalk have also been found under the City of London. A relatively poor grade of chalk is found in Arkansas, Iowa and Texas of the United States, al-

though most of the calcium carbonate found in North America is in the form of limestone and marble.

The chalk flints that are found in the lower parts of some chalk deposits are interesting forms of a rock that is also of animal origin. Flint is an amorphous form of silica, or silicon dioxide, that has been deposited by water trickling through the chalk. The water derives this silica from the siliceous remains of certain sponges and from a group of one-celled animals called radiolarians. Sea water contains very little silica but these little creatures have the power of transforming particles of clay, which is impure silicate of aluminum, into flint of which their skeletons are composed.

Many well-known forms of chalk are met with in every-day life. First of all there is the prepared chalk which is used in medicine and in dental preparations. This is a natural form of calcium carbonate which has been mechanically purified by the process of elutriation or water sifting. Precipitated chalk, also used in tooth powders, is an artificially prepared form of calcium carbonate. It is generally made by mixing solutions of chloride of calcium and washing soda, then collecting, washing and drying the insoluble precipitate that separates out. Immense quantities of chalk are used in the paint industry under the names of whiting, Paris white and English cliffstone. Whiting is also used as a polishing powder and in the manufacture of putty. Gilder's white and Vienna white are purified forms of chalk that are also used as pigments. Then there are the familiar drug store preparations containing chalk such as gray powder, chalk mixture and chalk and orris.

When we turn to French chalk we are dealing with a mineral substance that bears no chemical relationship to the true chalk but which, instead, is composed of silicate of magnesia. Red chalk or reddle is another mineral substance sailing under false colors since it is composed of clay and oxide of iron.

An interesting fact, not generally known, is that most of the blackboard chalk is now made of plaster or calcium sulphate rather than of the true chalk. The partially dried calcium sulphate used in making these crayons is the well-known plaster of Paris which is capable of taking up water to become hard and rigid in the mold. Various colors may be given to the crayons by adding pigments to the mixture of plaster and water just before molding.

Turning away from chalk the next member of the calcium carbonate family for our consideration is limestone. A close examination of massive or shell limestone reveals its organic origin. In some cases a most entrancing exhibit of minute sea life is laid before the eye. There are shells like those of tiny oysters, tiny clams, tiny snails and tiny things that perhaps you never saw before. While the shells, corals and other remains may be conspicuous in some limestones there are others in which they may be quite obliterated. In much of the compact limestone the shells and remains of which it is composed have been largely ground up by the action of the sea and the waves, and afterwards consolidated. Then it is possible that the calcium carbonate by going into solution and being redeposited has helped to cement and consolidate the limestone. Limestones for building purposes are necessarily compact and thoroughly hardened.

One of the most widely used limestones in the United States is taken from the Bedford deposit in Indiana. There it occurs in massive beds from twenty to seventy feet thick and is said to underlie an area of seventy square miles. The chemical analysis of this stone has shown ninety-seven per cent. of calcium carbonate.

Dolomitic limestone contains varying amounts of magnesium carbonate as well as a large proportion of carbonate of calcium. Much of the common limestone of the United States is dolomitic in character. There is an immense hole in the ground not far from Philadelphia from whence comes a high-grade of this so-called dolomite. It is quarried there by a corporation composed of two graduates of this college in the class of 1873. The magnesic portion of the dolomite is converted into various grades of magnesium carbonate at the largest magnesia factory in the world which is located at Ambler, Pa. Their by-product is calcium carbonate which is used, among other things, as an insecticide in the cotton belt, and for mosquito larvæ, where it is dusted by aeroplanes.

Hydraulic limestone is an impure earthy variety containing clay and is the raw material from which a cement can be made that will set under water.

Lithograph stone is a compact, fine-grained variety of limestone of a very porous nature. Most of the lithograph stones of the best quality have come from Bavaria. These stones can be highly polished

and in that condition are capable of taking the finest imprints. For this reason they are used in a valued process of the printer's art called lithographing.

In addition to its use as a building stone, limestone enters into the manufacture of glass, into the production of washing soda by the LeBlanc process and into the making of lime. It serves to remove impurities in the smelting of iron ore and powdered limestone has been found of considerable value in restoring fertility to certain soils that have become sour and acid.

Another well-known member of the calcium carbonate family is marble. The name marble is now given to most any hard, crystalline form of fine-grained limestone that will take a high polish. From its structure and general characteristics we are led to believe that marble is a metamorphic rock that has formed by the effect of enormous pressure and heat upon shell limestone. It has actually been shown that if the pressure is sufficiently great, calcium carbonate may be melted at extremely high temperatures, in a closed vessel, without decomposing, and that the mass upon solidification has a crystalline structure like marble.

The purest form of marble is white. The colored and mottled appearance that is so often observed comes from impurities. The highly prized black marble gets its color from bituminous matter.

A few of the famed deposits of marble that are noted because of the abundance and the quality of the stone, are located at Carrara in Italy and in our own states of Vermont, Georgia and Tennessee.

The Georgia deposit consists of a block of marble four miles long, three-eighths of a mile wide and two hundred feet deep. This bed is estimated to represent a financial asset to the State of Georgia of more than twelve billion dollars. Its analysis has shown nearly ninety-nine per cent. of calcium carbonate. Some of this stone has found its way into the construction of the Girard Trust Building of Philadelphia.

Immense quantities of marble are used in the construction of buildings, memorials, mausoleums and the like. The magnificent statue of Lincoln at the Lincoln Memorial in Washington is carved out of marble which was taken, by the way, from the terra firma of the old rebel state of Georgia. This heroic statue is twenty feet high, weighs a hundred and seventy-five tons and totals approximately three thousand cubic feet.

Marble dust is familiar to some of us as the name given to one of the earliest sources of carbon dioxide as it was produced for making soda water.

Coral is an organic rock related to chalk in that it too is composed of calcium carbonate. It generally grows in the form of a branching skeleton often assuming beautiful flower-like forms.

The living coral animal is a tiny one-celled individual encased in a hard shell of calcium carbonate which it has secreted. The individuals, or polyps as they are called, consist of little more than a stomach with a mouth surrounded by tentacles. They grow in vast branching colonies, the tiny individuals being sheltered in little cups of calcium carbonate which invests the whole colony.

By their organized and concerted efforts these tiny coral animals have been able to build marvelous creations of nature such as the barrier reefs and the coral islands. When we consider the size of this little animal and how necessarily slow its work must be, then indeed the great barrier reef off the east coast of Australia, which is more than a thousand miles long, truly becomes one of the wonders of the earth.

When the Challenger expedition explored the bottom and the islands of the Atlantic Ocean, in 1873, it was learned that the Bermuda Islands rested upon a lonely column in a deep sea. For a while it was difficult to reconcile this with a conclusion of Darwin's that the coral animal was only active within a hundred fathoms below the surface of the water. Later on, in an effort to secure fresh water by drilling a well down over a thousand feet, it was found that the limestone and the coral rock formed only the cap to an extinct submarine volcano that reached almost to the surface of the sea.

Many pieces of ornament and necklaces made of polished red coral are composed of the remains of multitudes of these little tropical sea animals.

Considerable superstition was attached to coral and medicinal properties were assigned to it during ancient and medieval times. It is worn in certain parts of Italy at the present time as a charm against the evil eye.

Some of the strikingly beautiful formations of calcium carbonate are the stalactites and the stalagmites of the underground caverns. Notable among these caves are those at Somersetshire, Eng-

land, the Luray and Endless Caverns of Virginia, the Mammoth Cave in Kentucky and the Carlsbad Caverns of New Mexico.

The names stalactite and stalagmite come from two Greek words, stalactite from a word meaning oozing and stalagmite from a word meaning dripping.

There are mineral formations of rare beauty and splendor in many of these caves and some of them may well be described as subterranean fairy lands. The solvent action of carbonated water upon limestone and the subsequent separation of this limestone from solution has carved beautiful forms resembling chandeliers and large pendants many of which ring like chimes when tapped.

Constant percolation and the dripping of water saturated with calcium bicarbonate causes the formation of the long stalactites of calcium carbonate that hang from the roof of the cavern like icicles. The drops falling upon the floor of the cavern leave a deposit of calcium carbonate in the form of an upright rod called a stalagmite. In some cases the stalactites and the stalagmites ultimately join forming complete pillars in the cavern. In course of time both stalactites and stalagmites, owing to molecular changes, tend to acquire a crystalline structure.

The calcium bicarbonate in solution, which is responsible for these formations, is about thirty times more soluble than the calcium carbonate and the deposits are formed as a result of the escape of carbon dioxide gas from the solution thereby causing the relatively insoluble calcium carbonate to separate.

Other calcium formations that are produced by this same type of chemical sedimentation are the snow-white deposits from some of the geysers and hot springs, the so-called petrifying springs, and the travertine rock that comes largely from a river in Italy and was used in the construction of St. Peter's Cathedral at Rome.

The subject of shells in itself opens up a vast array of natural forms of calcium carbonate. The mollusks, a group commonly known as shellfish, are the shell builders to which we are indebted for our supply of shells and there are fifty thousand species of mollusks now distinguished by name. The name mollusk comes from the Latin word mollus, meaning soft. The mollusk builds the shell by secreting calcium carbonate from sea water and adding it layer by layer to the growing shell.

The oyster, which is one of our best known examples of an edible mollusk, is pre-eminent as the source of the world's supply of pearls. Not only do the shells of oysters consist largely of calcium carbonate but the highly prized pearl itself is chiefly composed of calcium carbonate which has probably been formed by the oyster about an invading parasite.

Mother of pearl is taken from the lining of shells and pearl buttons are cut from the shells of the fresh water clam. One of the beautiful products of shells that is used as an object of adornment is the cameo. Cameos are generally cut from helmet shells and the finest shell cameos are made in Genoa and in Rome.

Less than fifty years ago there were several forms of calcium carbonate used in medicine. Among these were Prepared Oyster Shell, Cuttlefish Bones, Egg Shells, Powdered Red Coral, Crab's Eyes and Crab's Claws. Most of these have passed out of general use although cuttlefish bones are largely used today in bird cages for birds to sharpen their bills upon. The soft portion of the cuttlebone is still used as an ingredient of various tooth powders.

Let us now consider the nature of this calcium carbonate. It is a compound that contains three simple elements, namely, calcium, carbon and oxygen. In one hundred pounds of pure calcium carbonate there are forty pounds of calcium, twelve pounds of carbon and forty-eight pounds of oxygen, all chemically combined so that the identity of each has been completely changed. When calcium carbonate is strongly heated it loses weight because of the escape of an invisible gas called carbon dioxide. The prolonged heating of a hundred pounds of pure calcium carbonate, until there is no longer any loss in weight noted, yields forty-four pounds of carbon dioxide and leaves behind fifty-six pounds of a residue called lime.

Now lime and carbon dioxide show a very strong affinity for each other and apparently do not like to remain apart. The result is that when they are brought together, under ordinary conditions, they promptly combine again to form more calcium carbonate. It appears then that there are times when carbon dioxide and lime may be regarded as the descendants of calcium carbonate and the ancestors of more calcium carbonate.

The attraction of lime for carbon dioxide and vice versa may be illustrated by passing carbon dioxide into lime water, which is a

solution of hydrated lime. A cloudiness appears in the lime water because the lime is being thrown out of solution as the insoluble calcium carbonate. It is this affinity that makes lime a valued ingredient in mortar since the slaked lime eagerly takes carbon dioxide out of the atmosphere and gradually sets by changing to a stone-like form of calcium carbonate.

Very few chemical substances are better known or have a wider industrial application than lime. It has been known and used since ancient times. Dioscorides described the preparation of caustic lime, by calcining ordinary marble and the shells of snails, nearly nineteen hundred years ago. He also referred to the burning, biting, caustic, scab-making strength of the lime. It must have been known long before then since it has been used in making mortar from prehistoric times.

Lime is generally made by the prolonged heating of limestone or marble at high temperatures. Marble requires a higher temperature than limestone in order to bring about a complete change. Lime which has been burned too strongly is often rejected by workers as being dead-burnt but pure calcium carbonate is not so apt to become dead burnt as that containing impurities of clay or silica.

The limelight, which is now largely replaced by the electric arc, is a blinding, white light produced by exposing lime to the intense heat of the oxyhydrogen flame. Lime and carbon, when heated together in the electric furnace, form a substance that is well-known under the name of carbide. It may be recalled that carbide is the material, which, when treated with water, yields acetylene gas. A great deal of lime enters into the production of a fertilizer material called cyanamide. Because lime attracts water it is used as a drying agent to remove moisture from many gases. Immense quantities of lime are used in building operations for the production of mortar and plaster. A valuable insecticide under the name of Bordeaux Mixture has been recommended by the United States Department of Agriculture and is composed of slaked lime and sulphate of copper solution.

When lime is treated with about one-half its weight of water a reaction takes place and considerable heat is produced. The lime is then known as slaked lime. If more water is added so that the slaked lime remains in milky suspension the mixture is known as

milk of lime and is commonly called whitewash. If sufficient water is added to completely dissolve the lime the result is a solution that represents the well-known lime water of the drug store.

The carbon dioxide that escapes when calcium carbonate is strongly burned has become one of our most serviceable gases. It is constantly being exhaled in the expired air from the lungs of breathing animals. Enormous quantities of this gas have also been given up to the atmosphere during the process of fermentation, in the burning of fuels containing carbon and in the making of lime from calcium carbonate. Notwithstanding all this the atmosphere maintains its uniform carbon dioxide content which is relatively very small. Then what becomes of all the carbon dioxide that is constantly being produced?

The answer to this question involves a most wonderful example of co-ordination in the life processes of the animal and vegetable kingdoms. Green plants have the power to take this carbon dioxide out of the atmosphere, under the influence of sunlight and the chlorophyll that they contain, changing it into nutritious carbon compounds which, in turn, may serve as food for the growing animals. Since carbon dioxide is a heavy gas and a gas that does not sustain life it is only reasonable to suppose that were it not for the activity of these plants in keeping down the carbon content of the air that we breathe, all animal life would perish by suffocation.

Carbon dioxide is without color and odor but like most invisible gases it betrays its presence by what it can do. It is the gas that furnishes the sparkle and the bite to all our soda water and carbonated beverages. The people of the United States have recently consumed sixty million pounds of carbon dioxide within one year in their soft drinks alone. It is the gas that causes the swelling up or the leavening that gives to bread its desirable spongy character. It has been found to add to the keeping qualities of butter and ice cream when churned with these materials. Cookies and biscuits are preserved in air-tight containers that are shipped abroad by being packed with carbon dioxide. Large quantities of the gas are used in the Solvay process for making washing soda and baking soda. A flame will not burn in carbon dioxide so we find the gas formed and delivered, under pressure with water, from a familiar type of fire extinguisher.

We have already referred to the important part played by carbon dioxide in the formation of limestone caves and caverns and we shall now consider how both carbon dioxide and calcium carbonate give the so-called hardness to water.

Hard water is water that requires an unusual amount of soap to form a lather. Nearly all mineral and spring waters hold more or less calcium salts in solution generally in the form of the bicarbonate or the sulphate. Such waters are said to possess hardness. Waters containing little or no calcium salts in solution generally lather well with soap and are said to be soft. The reason why hard waters require more soap than soft waters to form a lather is because the calcium forms white insoluble substances with the fatty acids of the soap. It is obvious that hard waters are objectionable for washing purposes and it is often necessary to take steps to correct or to remove this hardness.

When hard water is boiled the calcium bicarbonate is decomposed, carbon dioxide is given off and calcium carbonate is precipitated. This treatment is generally sufficient to correct the temporary hardness in any given specimen of water. Any hardness still remaining in the water is called permanent hardness and is generally caused by calcium sulphate or gypsum. In order to remove permanent hardness chemical water softeners such as borax or washing soda are often employed. When temporarily hard waters are used in boilers the calcium carbonate that separates out adheres to the sides and is called boiler scale.

We are constantly learning more and more about calcium carbonate and its derivatives. In this limited discussion we have pointed out sufficient to show how dependent we are upon this interesting group of materials.

It would be difficult indeed to select a mineral substance that tells us more about the history of the earth on which we live than calcium carbonate itself. The immense deposits of chalk, coral, and limestone give mute but positive testimony that millions of tiny creatures lived thousands of years before the dawn of our recorded history. Vast multitudes of these little stone builders are at work this very moment building formations that are not dreamed of today but which will be man's inheritance in the ages that are to come.

WHY SOAP?

By E. Fullerton Cook, Ph. M.

Soap seems to occupy a very humble place in the affairs of the average home yet so important is its service that the health of a nation may almost be gauged by the amount of soap used.

It is a factor, too, in the comfort of the people. It is stated that the absence of soap was the deprivation most felt by those countries where the demands of the World War created a shortage in raw material.

But "Why Soap"? Probably this question can be answered by the soap maker who should know why soap is used. The widely flung claims of national and international advertisers tell one side of the story. They take for granted that the use of soap is universal, they know it to be a modern necessity, they vie with each other to perfect their product and offer the greatest value.

The current magazines reveal several of the uses for soap. For instance, full pages are devoted to telling the virtues of well-known laundry brands. One "Loosens the dirt you used to rub away," another "Won't redden the hands," a third "Makes washday easier," and is "gentle to clothes," still another "makes housework shorter and easier." Time saved, less work, better results—the appeal is strong!

But after all it is largely *how* to use soap that counts. Several of the larger producers of laundry soap conduct research laboratories to learn how to use soap for the best results and their advice should reach every household.

A second set of advertisements cover soaps for facial, hand and bath use and the chief appeal is for greater beauty. "Her beauty laughs at years," "Simple care triumphs over beauty's enemies," "The prettiest girl in her set," "A skin you love to touch," are some of the familiar and catchy phrases. One soap maker tells of "matchless fragrance," another of "assured health" through the removal of germs.

A third group of advertisers talk of shampoos to "cleanse and gently stimulate the scalp," and to produce "youthful and sparkling hair."

To men the shaving soap manufacturers make their varied appeals, the most potent one being "instantly softens the toughest

beard." Another type of soap is for the hands of the machinist or perhaps the amateur or emergency auto mechanic, and so the common applications and needs for soap are emphasized by every publicity medium.

But there are a hundred other reasons "why soap." In the textile trade it is extensively employed in the conditioning of wool and cloth, in surgery it serves as an agent in the preparation of an aseptic field for operation. It also becomes the base for liniments, as in "chloroform liniment," or a dressing for burns as in "Carron Oil." A certain type of soap is the main constituent in plasters and another form renders powerful coal-tar germicides miscible and usable, producing preparations of the "Lysol" type. Soap may also act as the combining medium between oil and water forming emulsions, as in "Almond cream," or make possible valuable lubricants when combined with petroleum oils.

Another type of soap becomes the solidifying ingredient in the well-known glycerin suppositories and in "solidified alcohol" or "canned heat." In another combination it is the chief ingredient in "vanishing cream."

After this array of facts need the question be asked, "Why soap"? The actual daily needs of our civilization demand it.

It has remained, however, for our century to develop manufacturing processes which bring this commodity within the reach of all.

The origin of soap is hidden in the unwritten history of early mankind. What is usually known as "soap," the washing kind, was, according to tradition, first brought to Rome from the north countries. One may readily imagine a crudely formed limestone fireplace, a wood fire, and the cooking of a stag or boar. The next step would naturally be the use of ashes to clean the kettle.

Here were all the elements of soap making. The wood ashes and lime supplied the lye, ready to saponify the fat. The product was soap. True this crude product was far removed from our modern soap but such might have been its discovery and even if accidental, we are deeply indebted to the one who first observed the result and handed on the information.

The upward rise of man has necessarily been slow. Countless ages have passed in advancing the first few steps. Between the crude discoveries in science of centuries past and the perfected products

of today lie the mysteries which distinguish man from the beast. It is that upward urge within the human race, that determination to improve, that hunger for knowledge, which is the ultimate hope of the world.

The Hebrew word "borith," in Jeremiah II, 22, translated "sope" and also the word "nether" translated, "fullers' sope," in Malachi III, 2, are both supposed to refer to some form of lye, not what is now called "soap."

Aristophanes and Plato (B. C. 400) both refer to the use of lye, but not to soap. The earliest known reference to a soap of the modern type seems to be by Pliny, who died during the eruption of Vesuvius, 79 A. D. He says with reference to the treating of scrofulous sores, "Soap too is very useful for this purpose. This is an invention of the Gauls for giving a red color to the hair. It is made from tallow and ashes, the best from beechwood ashes and goats' tallow. There are two kinds, solid and liquid. Both of these are used by the Germans, by the men in particular, more than the women."

It is said that during the excavation of Pompeii a complete soap factory, and soap in perfect condition were discovered.

Apparently, however, at that time soap was not used for cleansing and there is no evidence that it was employed for that purpose at any of the ancient Roman baths.

The first writer to mention soap as a cleanser was that very remarkable man, Claudius Gelen, a renowned Roman physician born A. D. 130. He suggested a soap made from fat and lye which softens and removes dirt.

Early people had long used certain plants to assist in cleansing, presumably those containing saponin, such as soap bark, and the cleansing properties of "fullers' earth" have also been long known.

The physicians of two thousand years ago were also familiar with medicinal products which were soaps chemically. One of these was made by shaking oil with quicklime. This product was similar to one official in our modern Pharmacopœias, known as "Lime Liniment" and already referred to as "Carron Oil."

The making of washing soaps was for many years largely a domestic practice. As has already been implied, fats are essential to soap making and that used in the crude household soap was chiefly the oil drippings or "fryings" from cooking. Lye is also a necessary

ingredient for soap and for centuries its only source was wood ashes. This was crudely separated by "leaching," in which a so-called "lye-hopper" was used (Fig. 1), the ashes being slowly percolated by water to dissolve out the mixture of crude potassium carbonate and hydroxide.

For two hundred years soaps have been made in Europe for general sale, especially in the countries bordering the Mediterranean where an abundance of olive oil was available and today the terms "Castile" or "Marseilles" soap still implies the type of soap made in Spain or in French cities.

The making of soap was dependent upon securing sufficient soda or potash. For many centuries the latter was available only from wood ashes and while some soda may have come from deposits found in the coast countries of Asia or Africa, most of it had to be secured from the burning of sea plants.

Two developments occurring at the beginning of the nineteenth century changed the situation completely and made possible the development of the modern soap industry. Chevreul announced the result of his researches into the constitution of oils and fats, showing them to be combinations of fatty acids with glycerin and Leblanc discovered a method for making "soda" from salt, that is, sodium carbonate from sodium chloride. Like so many pioneers Leblanc did not live to have the value of his discovery appreciated. His early production of soda ash on a commercial scale in a factory erected at St. Denis, near Paris, under the support of the Duke of Orleans, was interrupted by the dark days of the French Revolution. The Duke of Orleans was guillotined, the factory confiscated and Leblanc forced to reveal his process to the State. Though his factory was returned in 1800, Leblanc was unable to secure financial help and in 1806, in poverty and despair, he took his own life. In 1824 James Muspratt, in England, undertook the commercial production of soda ash by the Leblanc process and with great success, the process proving to be of untold benefit to the world, especially as soda ash is also an essential ingredient in glass manufacture.

The classical investigation of the chemistry of oils by Chevreul, and the cheap production of soda lye marked the beginning of the modern soap industry. Increased sources of raw material have also been developed and recently the hydrogenation of fats has been one of the factors in producing cheaper soaps of good quality. By this

Fig. 1—Lye Hopper.

From Modern Soaps, Candles and Glycerin—L. L. Lamborn (D. Van Nostrand Co., N. Y.).

process odorous fish oils and many thin oils of the olein type are changed to stearins and made more fit for soap making. Another important result of understanding the chemistry of soaps and the development of modern methods and machinery has been the saving of the by-product glycerin, which for many years was turned into the sewer with the "spent lye."

This valuable triatomic alcohol is extensively employed as a solvent and preservative in pharmaceutical preparations and, at this time, is of special interest and advantage in replacing alcohol, because of its comparative cheapness, non-intoxicating character and freedom from government regulation and tax.

Glycerin is also of great economic value as an essential ingredient in the production of nitroglycerin from which dynamite is made. In peace times this commodity is invaluable in mining operations and in time of war becomes an important high explosive.

An element entering the economic question of soap production of today is the use for food of many of the oils and fats formerly only suitable for soap or candle making. This applies to the oils from the olive, peanut, cotton-seed and corn and also to cocoanut and tallow, the latter finding a place in butter substitutes.

The fats available for soap making today are from the sources just named in part but mostly the inferior grades, unsuited for foods, but other substances are also available and the soap maker is largely governed by the market price as to which ones he selects, many of them being interchangeable in soap production.

Other oils have extensive commercial uses as linseed oil in paints and castor oil as a medicine and lubricant so that they are not generally available for soaps.

But something should be said of the chemistry of fatty substances as demonstrated by Chevreul that there may be a better understanding of the problem. All neutral fats of animal or vegetable origin consist of glycerin or glyceride combinations with fatty acids. The two most important of these acids are oleic, which is liquid at ordinary temperatures, and stearic, which is a solid. As might be supposed glyceryl oleate represents the chief constituent of many fluid oils while tallow is mostly glyceryl stearate. The difference chemically between these two acids is represented by two additional hydrogen atoms in the stearic, and this explains why the new hydrogenation process, whereby hydrogen is added to the mole-

cule, through the aid of a catalytic agent, changes the oleins and other higher fatty acids to stearins.

Certain oils contain related but slightly different and distinctive fatty acids, such as palmic acid from palm oil, ricinic acid from castor oil, caproic acid from cocoanut oil, etc. Each of these acids has distinctive qualities which give different characteristics to soaps made from them.

In the saponification process the glyceride is replaced by the base, a salt being formed such as potassium or sodium oleate or stearate or palmitate, etc., and glycerin is liberated. A typical reaction is as follows: $C_2H_5(C_{18}H_{33}O_2)_3 + 3NaOH = C_2H_5(OH)_3 + 3NaC_{18}H_{33}O_2$.

The quality of the soap in a measure depends upon the completeness of the saponification and the care taken to produce a neutral or almost neutral soap.

For certain purposes, such as for exceptional detergent or germicidal value, as in "soft soap," to be used for cleansing the hands of a surgeon and in preparing an area for a surgical operation, a slight excess of alkali is desirable, but for toilet purposes and for the laundry the neutrality of the soap is essential. A few soaps are superfatter, that is, contain an excess of fat but these are only used for special purposes, such as to remove an excess of machine oil or some such form of dirt.

The kind of alkali used also has an important influence upon the character of the soap. Potash produces soaps of a soft consistence, and until recently was considered necessary for their production. It has been shown, however, that it may be replaced in part at least by soda without seriously modifying the consistence of the finished product. The home-made soaps from potash lye obtained from wood ashes produced a semi-fluid mass, slimy and slippery, which was not very satisfactory to keep or to use.

Soda in the form of the hydroxide, chemically NaOH, produces the so-called hard soaps, whether the fatty acid be liquid or solid, although the consistence of the latter increases or decreases in proportion to the consistence of the finished soap.

Another characteristic of the fatty acid influences the solubilities of soaps and thus has a bearing upon their adaptability: All soaps except those made from cocoanut oil are insoluble in salt (sodium chloride) solutions and therefore only cocoanut oil or chiefly

cocoanut oil must form the basis for what is known as "marine soap" to be used with sea water. This quality of soaps is taken advantage of in their manufacture to separate the glycerin, salt being added to the saponified mixture, causing it to rise to the top of the soap-boiling kettles (see Fig. 2) in more or less granular form, leaving the glycerin, "spent lye" and salt solution at the bottom to be drawn off and treated for the glycerin. The stage of the process is known as "graining." When the glycerin has been removed the separated soap is again heated and water added to restore a uniform consistence and this warm mixture is then drawn off into mixers, known technically

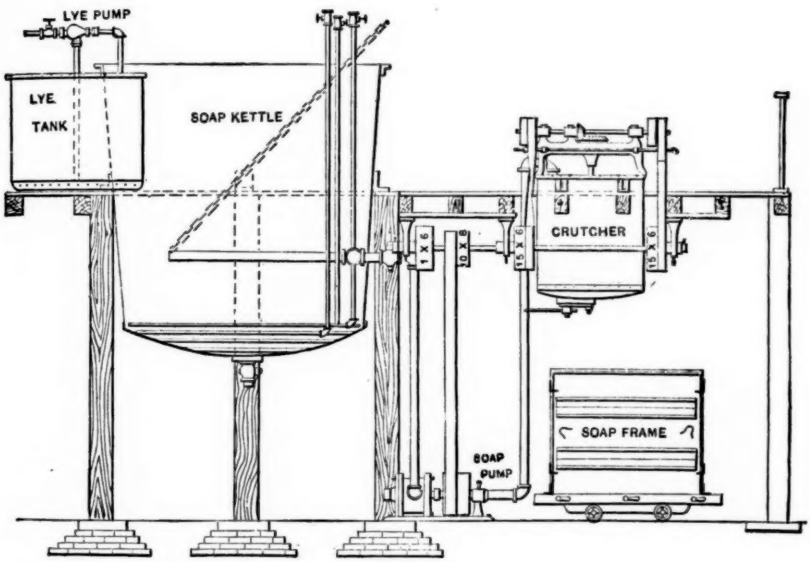

Fig. 2.

From Modern Soaps, Candles and Glycerin—L. L. Lamborn (D. Van Nostrand Co., N. Y.).

as "crutchers" (see Fig. 2), where, if the soap is a cheap laundry or washing soap, an inexpensive perfume may be incorporated, and a better consistence secured by actively stirring before the soap is run into "frames" to cool. If the soap is to be a "floating" soap, the "crutching" or beating is continued until sufficient air has been worked into the cooling mass to make the specific gravity less than that of water.

A "floating soap," therefore, means less soap and thousands of minute air spaces throughout the cake, which tend to increase its solubility and wasting qualities.

The "frame" (see Fig. 2) into which the soap is run to cool usually consists of an iron or steel box about 4½ feet long, 15 inches wide and 4 feet deep, mounted on wheels. The sides and ends are removable and each frame holds about 1000 pounds of soap. When the soap in the frame has cooled sufficiently the sides are removed and in due time the mass of soap is cut into slabs by forcing it against piano wires fitted to a frame, and these slabs in turn are cut in the same manner into bars weighing about three pounds each. In the cheaper laundry soaps these bars are further cut into cakes, and the cakes roughly stamped by a press, before being wrapped and boxed.

Much laundry soap is now being sold in powder and flake form. This not only enables the user to regulate the exact amount of soap used but also provides quick solution and is admirably adapted to the modern domestic or laundry washing machines. In the production of chip soap it is not necessary to run the warm fluid soaps into frames to cool as the crutched soap, while still fluid, is run between a series of cooled steel rollers and the thin film which dries on the rollers is mechanically scraped off at one stage of the process. It then drops to a movable belt and is carried into a warm closet, from which it emerges dry enough to market as "flake" or "chip" soap (see Fig. 3).

For the production of powdered soap the flakes must be more thoroughly dried and are then powdered in the usual manner.

It must be evident to all who know something of the nature of soap that an important factor in its actual value is the percentage of water it contains. Not only does this control the amount of soap available, but when large amounts of water are present a soap in cake form rapidly disintegrates when used and fails to give adequate service.

It may be startling information to some to know that often as much as 80 per cent. of laundry soap in cakes is represented by water. In flakes the water must be greatly reduced and is not often above 5 per cent. This is another reason for the preference of chip or flake soap over other forms, for laundry purposes.

Washing powders, on the other hand, are usually mixtures, rarely containing more than 20 per cent. of soap and often less. In addition to the soap they usually contain from 25 to 30 per cent. of "soda ash" (sodium carbonate), the remainder being water. This combination of soap and "soda ash" is particularly efficient in the

washing of clothes and, even if pure chip soap is used, the experts who conduct experiments in laundry methods advise the addition of soda ash to the first water.

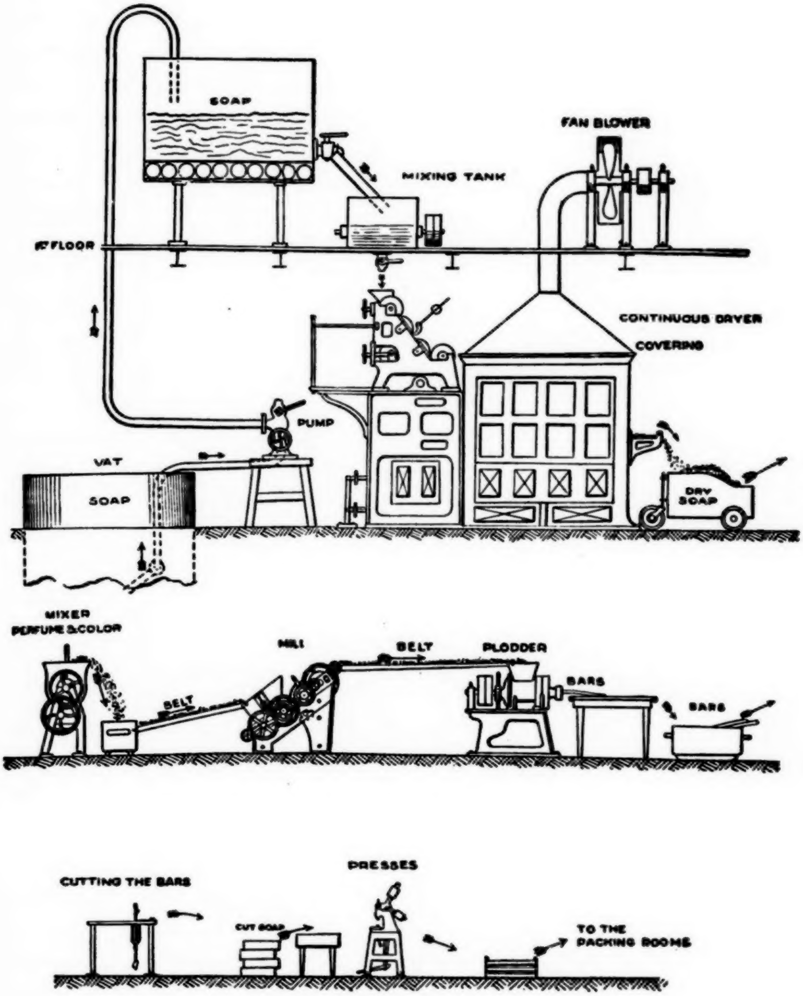

Fig. 3.

From Modern Soaps, Candles and Glycerin—L. L. Lamborn (D. Van Nostrand Co., N. Y.).

To produce the higher grade toilet or medicinal soaps the bars cut from the frames are reduced to chips by a chipping machine or scraped directly from the roller (see Fig. 3). These are further dried and then "milled" (see Fig. 3) by passing them repeatedly

through heavy rollers without heat, until a uniform mass results. During this process the coloring matter, if any, is incorporated and also the desired perfume or medicating ingredients.

This soft mass is then forced under heavy pressure into bars of the shape and size best suited to form the desired cake, the machine being called a "plodder" (see Fig. 3). These bars, while yet soft from the milling, are then cut into cake size and stamped into tablets.

The chief raw materials from which soaps are made are:

Bone Fat.—Extracted from bones boiling with water.

Cocoanut Oil.—From the cocoanut fruit, sometimes called "Copra." The chief commercial varieties are "Cochin," "Ceylon," and "pressed oil."

Palm Kernel Oil.—The oil pressed from the kernels of the palm fruit is obtained from the West Coast of Africa and from South America. The fruit from the same tree yields from the soft outer pericarp an oil known as

Palm Oil.—This is reddish brown in color and the red color persists in the finished soap unless bleached.

Olive Oil.—This oil produces the soap known as "Castile" and is mild and neutral and especially adapted to sensitive skins, and is almost universally used for babies. Such soap constitutes the official soap of the Pharmacopœia and is made from the cold pressed oil. Many other soaps are now being sold as "Castile soap," so that to obtain the original it is becoming necessary to ask for "Olive Oil Castile Soap."

Another grade of olive oil is also available, obtained from the residue after cold pressing and consists of skins, seeds, and pulp. It is obtained by extracting the oil with solvents. It is known as "olive oil foots" and is dark green in color. It is only suitable for making cheap household soaps.

Peanut oil is much like olive oil, but is not generally available in this country.

Cottonseed Oil.—This was formerly a waste product in the cotton industry, but is now extracted and has become not only an important soap stock, but when refined is largely sold as "sweet oil" and "salad oil" as a food.

Corn or Maize Oil.—In the preparation of starch from corn it is necessary to remove the soft oily tip of the grain of corn, known as the hilum, and from this an oil is pressed which is excellent as a soap stock and also as a food oil.

Soya Bean Oil.—This oil is largely imported from Japan and Far Eastern sources, and when available is a satisfactory soap stock.

Linseed Oil.—The importance of this oil in the paint industry lessens its use in soap making, but it produces an especially fine quality of soft soap, which has a less tendency to "fig," that is, separate crystalline masses of oleates than when made from other oils.

Castor Oil.—Other uses and the price restrict this oil in general soap making., but it is of special value in the making of transparent soaps and also in the production of a variety of hard soap for surgical purposes, which it is claimed will not hydrolize and therefore will not liberate free alkali. As it therefore retains neutrality when added to water, it is recommended as a medicinal soap or for use on sensitive skin.

Chinese Vegetable Tallow.—This fat from vegetable origin is harder than ordinary tallow and has a limited use in soap making, being sometimes blended with other fats.

Hydrogenated Oils.—In 1903 Normann perfected a process whereby hydrogen could be added to oleic and other fatty acids to produce stearic acid. He found that by exposing these unsaturated fats, in the liquid state, to the action of hydrogen, in the presence of a catalyst, such as finely divided nickel or other metal, the hydrogen was combined and the more valuable stearin produced. The process is commonly applied to whale, fish, cottonseed, linseed, and many other oils and these are used as a substitute for natural tallow.

Rosin.—This substance, the residue left in the still after distilling the oil (spirit of turpentine) from "gum turpentine," is readily saponified and is extensively employed in the formulas for many laundry soaps.

Soap makers claim that this is not simply a cheapener or filler, but that it increases the solubility and lathering properties of the soap and has true detergent value. It is usually found in cheap soaps to the extent of from 15 to 20 per cent.

Tallow.—This substance is obtained from animal fats and is probably the most important soap stock. Its source in the United States is mainly the huge packing houses and this explains why such firms usually conduct a soap factory as a related industry.

Fatty Acids.—Fatty acids are chiefly by-products in the making of glycerin. The fats are treated by one of the well-known processes, the glycerin separated and purified and the fatty acid thus made available for soap making. The soap maker in using this raw

material must take into account the fact that the valuable by-product glycerin has already been removed and, of course, deducts this from the price he pays.

Sodium Silicate is sometimes added to laundry cake soap. It has some detergent value and hardens the soap, preventing wasting. It is found in many of the cheaper laundry soaps.

Alkalies.—As already stated, soda in some form is the most important alkali used in soap making, not only because of its cheapness and availability in unlimited amounts but because the character of the soap it produces, a soda soap being what is known as a "hard soap." The forms of soda most frequently employed are "soda ash," which is a dried form of sodium carbonate and caustic soda (sodium hydroxide), the latter frequently being prepared from soda ash by treatment with lime. Soda in the form of a silicate is used also as a filler (see above). For "soft" soaps and for some other forms of soap, such as shaving soap, and liquid soap, potash, either as the hydroxide or carbonate, is used as the alkali. Ammonium hydroxide is sometimes used but only in special cases, chiefly in the production of soaps to be used as cleansers when mixed with volatile solvents. It is sometimes used as the alkali in the production of vanishing cream, in the form of ammonium stearate.

Kinds of Soap.

Curd Soap.—Curd soap is a soap separated by salt solution, reheated and mixed with sufficient water to form a smooth emulsion, run into frames, cooled, and cut into bars or cakes. It usually constitutes the bar laundry soap. It is frequently strong in alkali and usually contains fillers, such as sodium silicate.

Mottled Soap.—This form of soap shows a streak of color irregularly running through the mass. Originally it was caused by the addition of some metallic salt, as ferrous sulphate, manganese dioxide, or ultramarine. Originally such soaps were considered to be of superior quality, but the effects have been artificially produced, so that today mottled soap does not necessarily indicate a high-grade soap and often containing as little as 20 per cent. of actual fatty acid. The mottled soaps have very largely disappeared from the American market. Mottled soaps are a form of curd soap.

Milled Soaps.—When a high-grade soap stock has been made by the boiling or the cold process, and dried in the frames, it is then

cut into slabs and bars and subsequently chipped. These chips in turn are milled between stone rollers until the soap has acquired a uniform consistence. Such soap is much more serviceable when finally made into cakes and may be variously colored or prefumed. It is possible, of course, to apply this general process to low-class soaps, but whatever the basic stock a milled soap is much more serviceable and satisfactory than the same soap cut directly from the bars.

Soft Soap.—This soap, made from potash, or mixtures of potash and soda, and usually a liquid fat, has already been referred to. It is chiefly used medicinally, either as a cleanser for the hands of the surgeon or for preparing an operating area or in the treatment of the skin or scalp. It is most frequently employed in alcoholic solution under the name "tincture of green soap."

Disinfectant Soaps.—If some form of disinfectant such as cresol, or phenol, is added to soap stock during the milling, the soap is known as a disinfectant soap, even though the amount of added substance is not sufficient to produce effective germicidal action.

Marine Soaps and Hard Water Soaps.—For use with sea water and also for use with water containing lime salts, known as "hard" water, ordinary soaps are very unsatisfactory, because such salts precipitate the soap. It is possible, however, to make a soap which is soluble and therefore usable in such water, by employing cocoanut oil as the fat and possibly introducing a small amount of palm kernel oil. It is this form of soap which is sold under the above names.

Transparent Soaps.—For many years soaps there have been offered which are known as "transparent" soaps. These were originally prepared chiefly from mixtures of cocoanut and castor oils and the resulting soap dissolved in alcohol. When the excess of alcohol was distilled the residue was transparent. It has been found possible in recent years to produce much cheaper and quite satisfactory transparent soaps from mixtures of cocoanut oil and castor oil by the simple addition of cane sugar syrup. Such soap has a tendency to "fig," that is, in time to separate crystalline salts of fatty acids.

Liquid Soaps.—A largely used form of soap chiefly because of its economy and sanitary advantages is known as "liquid soap." This is usually an aqueous solution of cocoanut oil-potash soap, suitably colored and perfumed. It is found in modern hotels and

railroads trains and is used by means of a special apparatus which delivers a few drops of the soap without contaminating the balance.

Floating Soaps.—Floating soap is made by beating the soap in a crutcher soon after running it from the boiling kettles. Air is thus beaten into the soap as it cools and the resulting production is thus made lighter than water. While this lessens the actual weight of soap in a cake it is justified by adding to the convenience in the use of the product.

Shaving Soaps.—Soaps for use in shaving are usually made from carefully selected stock and carefully neutralized, to avoid any caustic action when using on the face. These soaps usually contain a large percentage of cocoanut oil. Shaving creams usually have such substances as tragacanth and milk sugar added in small amounts to increase the permanence of the lather.

Grit Soaps.—For cleaning the hands, when especially soiled with grease or machine work, soaps are offered which contain powdered silica mixed with the soap. Such soaps are frequently in paste form, although they may also be moulded.

Dry-Cleaning Soaps.—Soaps of this character usually consist of an ammonia or possibly a potash soap of oleic acid usually dissolved in a volatile solvent such as benzin. They are used to remove spots in clothing.

Scouring Powders.—Substances of this character sold extensively in a box with a perforated top are not actually soaps. The makers usually claim freedom from alkali or caustic effect. They usually consist of powdered volcanic lava and serve in a purely mechanical function as a cleanser.

How Does Soap Clean? Once more, the question may be asked, "Why soap?" In the opinion of some, soap is used because it acts as a lubricant. Through its use it becomes possible to rub the hands together or more readily scrub clothing or other surfaces and through its mechanical lubricant action the cleansing process is promoted. Another view of the reason why soap is efficacious is the fact that it usually hydrolizes when dissolved in water as may be readily shown by pouring an alcoholic solution of neutral soap into water. In a few moments the presence of free alkali due to hydrolysis becomes apparent if an indicator is added. Phenolphthalin will quickly turn pink, indicating free alkali. Many of the foreign substances on the hands and in clothing which are to be removed, are all of a fatty nature and it is argued that free alkali saponifies

this and thus promotes cleanliness. But while these two explanations of the value of soap are doubtless true and while they in part explain the value of soap, there is another quality which soap possesses, which is related to its colloidal character.

Soap possesses a quality which is known as "adsorption." When it comes in contact with foreign substances it seems to possess the quality of combining and rendering soluble many otherwise insoluble materials. This quality may be very clearly illustrated by mixing lamp-black with water and pouring the mixture on a filter. The water will pass through the filter leaving the black, greasy, lampblack on the interior surface. If some soap solution now be added to the mixture in the filter, the lampblack will be immediately carried through the filter showing the peculiar effect of soap on otherwise insoluble substances. If salt is now added to the mixture in the filter, thus precipitating soap, the lampblack immediately regains its insoluble character and will not pass through the filter.

Need more be added to this explanation for the use of soap? It is closely related to the aesthetic side of life. It is a vital factor in the health of every nation. It tremendously lessens the actual labor in the struggle for cleanliness. And the millions of little hands held out daily to be washed are of themselves an adequate answer for the universal prevalence and use of soap.

ABSTRACTED AND REPRINTED ARTICLES

ALCOHOL AND HUMAN PHYSIOLOGY.*[1]

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From the featured stories in the daily press one could reasonably infer that all Americans may be divided, as was Gaul, into three parts: first, those who are interested from afar in bootlegging as brigandic exploits of a high news value; second, those who talk of

*Read before the Intersectional Meeting of the Northeastern, Rhode Island, and Connecticut Valley Sections of the American Chemical Society, Boston, Mass., January 10, 1925.

[1] Reprinted from Jour. Indust. and Engin. Chemistry.

their bootlegging associations; each of these would like to be considered, as the elder Sothern would say, " a devil of a fella"; third, the very few who really have established contact with bootleggers. No matter to which class each of us belongs, there are certain definite facts relating to the influence of alcohol on the various cell complexes that go to make up our bodies that really throw us all into one class. As Professor Abel has so aptly put it:

"The best bred man indulging in wine with permissible moderation no more escapes the minor physical changes induced by it than does its meaner slave fail of its sense-destroying power when he drinks 'till he remembers his misery no more.' In the case of the former, the simple changes induced will never attain the degree when self-respect and social conduct are outraged, and they will pass unnoticed by all except those who are keen observers of their own mental state."

Alcohol as a Food.

It is not the purpose of this paper to catalog the obvious effects of *excessive* amounts of alcohol on human physiology and psychology. Moderate amounts of alcohol have effects on man that have been studied by many laboratories, and there are now several clearly proved facts that further study will not in all probability modify to any degree. Thus it is definitely proved that alcohol in not too large doses—that is, about 72 grams per day—is oxidized in the human body and the energy that it furnishes in its oxidation may contribute to keeping the body warm, to replacing other nutrients in the diet, and possibly to the performance of muscular work. Seventy-two grams of alcohol contributing 500 calories to the daily ration are more completely burned than 500 calories supplied in the form of almost any other substance, with the possible exception of pure sugar. This has been demonstrated clearly by actual measurements of the heat output of man inside of a respiration calorimeter, first, when subsisting on an ordinary diet, not containing alcohol, and then under exactly the same experimental conditions when 500 calories of fat or carbohydrate, or both, were replaced by 500 calories of alcohol. The experimental evidence is extensive and admits of no controversy.

Since a strong odor of alcohol in the breath of the drinker may be noted, it is commonly believed that a not inconsiderable amount of alcohol escapes through the breath, but the analysis of the air inside

of a respiration chamber where a man has remained for several days, taking alcohol in 500-calorie quantities, shows that only negligible amounts, scarcely 2 per cent., are thus vaporized.

It has been shown in the laboratory that alcohol when taken into the body is burned rapidly; indeed, its combustion begins almost immediately. This is known chiefly by a study of the respiratory quotient, the relationship between the carbon dioxide excreted and the oxygen consumed. Reasoning from these facts, one can take the ground that if alcohol can be so given as to produce the above effects—namely, to supply rapidly and easily 500 calories a day and replace other nutrients—and do no harm, it has certain justification for its moderate, regular use.

In the first place it is very easily assimilated—that is, alcohol requires no preliminary digestion and it is very soluble; second, it has a high caloric value, a value lying between carbohydrate on the one hand and fat on the other; and third, it is not very expensive. Aside from the internal revenue tax, alcohol under ante-bellum conditions, at least, sold for about 13 cents a liter (50 cents a gallon). On this basis it supplied energy somewhat more cheaply than does cane sugar at 11 cents per kilogram (5 cents per pound).

A practical use of alcohol in this manner was made by the late Professor Zuntz, of Berlin. In studying methods for fattening cattle, Professor Zuntz found that when starchy materials were fed to ruminants, in the ordinary way, owing to the long sojourn of the food in the intestinal tract, there was a very large amount of intestinal putrefaction. This resulted in a considerable loss of the energy in the starch, which was thus not available to the body of the animal for maintenance, for growth, or for fattening. Certain amounts of these starchy materials were therefore converted into alcohol and fed to the animals in this form as a part of their rations. Professor Zuntz found that, starting with a given number of potential calories in this crude carbohydrate material, after the conversion of a portion to alcohol there were actually more calories available to the animal in the ration, even with allowance for the losses due to fermentation, than could be obtained through the usual path of digestion of carbohydrates. Indeed, he believed that it might be recommended that animals just prior to going to slaughter could be very properly fattened by the addition of a certain quota of alcohol to their rations. To be sure, there would be a tendency

to fatty liver and excessive deposition of fat, which would contribute not a little to the sale value.

Such experiences should settle once for all the question as to whether or not alcohol is a food. Since it can replace fat and carbohydrate in the diet, and can be used to fatten stock cattle, it certainly must in all fairness be classed as a food, in spite of any mental reservations as to using the term "food" in this connection.

Two functions of food can probably not be filled by alcohol. It is highly improbable that alcohol becomes a part of organized tissue, and its exact function in the energy required for the performance of muscular work is by no means clear. We know that fat, carbohydrate, and protein do become a part of organized tissue, and do contribute to the performance of muscular work. It is important above everything else, however, to realize that, while in America the question as to whether or not alcohol is a food is essentially an academic one, in Europe millions of people use it regularly as a food.

Returning again to our laboratory investigations, we should note that laboratory experience is short, even the feeding experiments of Professor Zuntz being relatively short. In the laboratory, also, as well as in the animal-feeding experiments, the amounts of alcohol given are always moderate, never approaching the line of incipient intoxication. Certainly, therefore, it would seem as if alcohol, being a food, should be physiologically permissible, if used in moderation.

"Permissible" Amounts.

The great problem has been to decide upon the so-called "permissible" amount. In 1864 an English physician, Anstie, stated that he believed that about 30 cc. (1.5 ounces) of absolute alcohol per day could permissibly be taken. This limit has been used by numerous life insurance companies in obtaining information as to alcoholic indulgence.

In 1903 Professor Abel, of Johns Hopkins University, stated that a permissible amount would be 0.6 liter (1 pint) of beer or 0.3 liter (0.5 point) of light wine, or its equivalent in alcohol. The Abel estimate, which was made forty years after that of Anstie, is essentially one-half that of Anstie's. Thus we see a distinct tendency to cut down the so-called permissible amount as time goes on.

A further restriction is seen in the recent movement in legislation bearing upon the possibility of reducing the alcohol effect by diluting beverages to an alcohol content of 2.75 per cent. This would theoretically work in two ways: first, to retard the alcoholic effect, for it was commonly believed that the more dilute the beverage the less pronounced the alcohol effect; and second, to reduce the actual amount of alcohol taken, owing to the large volume of liquid necessary to secure the alcohol in a 2.75 per cent. solution.

Since both Anstie's and Abel's limits are designated as "permissible amounts," it is improbable that either planned to permit an amount just short of intoxication, as the word is ordinarily used, and it is obvious that several factors other than the danger of incipient intoxication determined the selection of these permissible amounts.

Physiological and Psychological Tests.

We are all familiar with the sense of well-being after a meal. This is a common experience after taking practically all foods. Alcohol produces to a degree approximated by none of the regular food materials psychic effects of rather far-reaching significance. Certain of these, such as buoyancy and euphoria, are accountable for much of the pleasure derived from alcohol. Even its deep narcosis is enjoyed by those who would "drown their sorrows."

A study of the physiological effects of moderate amounts of alcohol is essential before forming an opinion as to whether this or that quantity is scientifically permissible. Social environment changes. Urban life has become intense. Great mechanical agencies involving human control now enter into human activities as never before. Man's normal reactions to such environment and his reactions after "permissible amounts" of alcohol require examination before a standard of 1864 or, indeed, of 1903 can be considered as permissible in 1925. Unfortunately, most of the psychological studies on alcohol have been somewhat crude, and early psychological technic has been the basis for much of the disrepute unjustly attributed to modern experimental psychology.

In the earlier studies there was a scandalous lack of controls, and the possibility of practice effects in the different operations selected was too frequently overlooked. To assort beads of different color or to fit blocks of various shapes into different holes is a

trivial task for an intelligent man. On the first day he may do it with interest, owing to the novelty of the conditions. On the second and third days he may be insufferably bored. On the first day no alcohol may be given, and on the second day alcohol. The poorer performance on the second day has only too frequently been ascribed solely to the alcohol effect.

Furthermore, many processes were selected in which the subjective impressions of the experimenter and of the subject of the experiment frequently played havoc with whatever true scientific value there was in the observations. Laying emphasis upon the reflexes, reactions, and motor co-ordinations, an experimenter should select a technic having an opportunity for a minimum amount of introspection or personal impression. Another important point frequently overlooked is that when experimenters are their own subjects, as is not infrequently the case, there is always an instinctive and unusually keen interest on the alcohol days, with a great lack of interest on the normal or control days. Finally, many of the processes—in fact, most of the processes earlier studied—are capable of voluntary re-enforcement, as, for instance, in assorting beads a man can personally determine his speed, which may be governed by his interest in the process.

In the alcohol program of the Nutrition Laboratory it was decided that knowledge as to the physiology of nerve response and motor co-ordinations would have greater value and such measurements would be capable of less autogenic re-enforcement. Thanks to the skill of Prof. Raymond Dodge and to the fact that for the past eight years Prof. Walter R. Miles has been devoting his time to the perfection of technic and to studies of the human response to alcohol under conditions in which voluntary control has been recognized as the disturbing factor and one to be eliminated in all critical experiments, it is possible to speak with a degree of conviction based upon their extensive findings.[2]

Four considerations seemed of prime importance in the conduct of alcohol research: first, exactness in the matter of alcohol dosage, not only of dilution, but likewise as to the mixture of the diluted alcohol with any foods or fluids in the stomach; second, provision for suitable control experiments, which should include not only con-

[2] Dodge and Benedict, *Carnegie Inst. Wash. Pub.*, *232* (1915); Miles, *Ibid.*, *266* (1918); *333* (1924).

trol days without alcohol, but also control periods prior to alcohol ingestion; third, a liberal discarding of first or practice results with all trained subjects; and fourth, the provision of strictly objective measurement technics. All four of these factors seem to have been recognized by Professor Miles as never before in alcohol research.

The measurements employed were numerous, and may be classified as physiological and psychological. Of the first, records were made of the influence of alcohol upon the pulse rate, including the study of the heart with the string galvanometer and standard electrocardiograms, the skin temperature, the metabolism—that is, the oxygen consumption—the alcohol content of the urine and blood, diuresis, the knee jerk, and the protective lid or wink reflex. The psychological measurements included reactions of the eye to a stimulus and the reading of words as exposed. The electric shock threshold, the threshold for visual acuity, a series of motor co-ordinations, including typewriting, eye movements, finger movements, discrete eye to hand co-ordination, continuous eye to hand co-ordination, and static equilibrium, were also measured. The transliteration of a special code was included in one series.

The measurements of the heart action, skin temperature, and metabolism, and the analysis of the urine and blood samples were all made by well-known technics. The patellar reflex, better known as the knee jerk, was graphically recorded on smoked paper, with the thickening of the quadriceps muscle used as a measure; thus a thoroughly objective measurement was secured. For the protective lid reflex or wink reflex, an artificial eyelash was attached to the eyelid and the shadow of this eyelash photographed upon a plate. With a sharp sound provided for a stimulus, the latency of the lid reflex, as well as the amplitude of movement, could be photographically recorded. Any false winks or inconsistencies in performance were instantly noted.

Of the psychological measurements special interest is attached to the eye reaction, in which the time required in turning the eye to a new point of regard after suitable stimulus was photographically recorded; for an act that plays an important role in all human experience is the quick response in the necessary movement of the eye from one location to another. The visual acuity—*i. e.,* keenness of vision—was measured by placing a visual acuity object at the end of a dark hood. A series of alternating dark and light bands can be

made so small as to be indistinguishable or so large that one or two bands occupy the whole field. In the test these bands are gradually increased in width until the subject recognizes their presence and can state the axes at which they point. The importance of visual acuity in modern urban life can hardly be overstated.

Eye movements were measured by photographing the time required to move the eyes between the two fixation points about 40 degrees apart. The only neuromuscular test was of the rapidity of finger movement. By attaching a light leved to the finger and adjusting it to write over a moving kymograph drum, both the amplitude and rapidity of the movement could be recorded.

The eye-hand co-ordinations were studied with two of Dr. Miles's apparatus. One of these was the pursuit pendulum, where the hand is supposed to follow a pendulum from which water is issuing at a constant rate. A small cup is held in the hand and the amount thus collected is an index of the accuracy of the co-ordination. Continuous eye-hand co-ordination was measured with the pursuitmeter, an electrical device in which the subject is supposed to move with the hand a sliding rheostat so as to maintain on a galvanometer the exact position of a spot of light, thus indicating perfect electrical balance.

Static equilibrium, or the steadiness of standing, was recorded on smoked paper; a mechanical means of automatically summing up all movement of whatever size, in terms of their anterior-posterior and lateral components, permitted an analysis of the character of the sway.

It is thus clear that the number and types of measurements were sufficient to give a true picture of the psychological effect of varying amounts of alcohol upon the numerous subjects employed in this series.

Practically all measures indicated lessened organic efficiency. Thus the extent of muscle thickening in the patellar response was decreased about 21 per cent. With the protective lid reflex the latency was lengthened and the amplitude lessened. The elctrical threshold was usually less keen; that is, it required a stronger shock to produce the effect. The visual acuity was likewise lessened. The eye reactions were slowed, as was the word-reaction time.

The movements of the eye through an arc of 40 degrees (a test of muscle co-ordination) showed a decrease of 6 to 9 per cent.

Finger movement was decreased. The co-ordination with the pursuit pendulum and particularly with the pursuitmeter was much less adequate. In the series of observations on typewriting with skilled typists, the errors were increased nearly 40 per cent., although the number of strokes per second was but slightly decreased. The illegibility was increased 55 per cent. Finally, the code tests for transliterating letters showed decreased efficiency.

Throughout the entire series one rarely found evidence of any facilitation resulting from alcohol. It is not logical, however, or possible to draw the inference from this general picture of alcoholic depression that a similar situation would be met exactly in this form in an industrial environment. Although the studies on typewriting lead us directly to the office and the eye-hand co-ordination processes are quite similar to many of those in industrial environment, it should be noted again that there is little opportunity, if any, in the laboratory for autogenic re-enforcement. With most men in an emergency there is a strong effort to pull themselves together to meet it, and to make a spurt. Most of this stimulus, however, is missing in laboratory tests; and in industrial situations, or in a human's general relations to his fellowmen in his environment, the possibility for autogenic re-enforcement—indeed the high probability that this would play an important role—must not for a moment be forgotten.

Consequently, it is of the utmost importance not to transfer uncritically the results of laboratory observations to industrial environment; for not only autogenic re-enforcement, but the effect of practice in tests, the difference in interest in the experiments between alcohol and non-alcohol days, the normal fluctuation in the capacity for performance which is exhibited notably in an analysis of post-holiday results in the higher studies of efficiency in factories—all show that one may easily fall into error by not carefully considering possibilities of compensation. The lack of practice in an accustome operation which may be measurably unbalanced by one holiday, resulting on the following day in a distinctly lower amount and character of production, is certainly of great significance. If, then, variations can be found in individuals without alcohol, it is extremely important to note that in alcohol tests such possibilities of variation in output may be due to a holiday, which is otherwise supposed to provide for recuperation and for increased ability on the following day.

The "Use" and "Misuse" of Alcohol.

Having recognized the place of alcohol as a food, and having observed the laboratory psychological effects, we are now in a position to attempt to reconcile the present very conflicting views as to the moderate use of alcohol. It is surprising to note that in practically all the discussions of alcohol emphasis has been laid upon excessive use and too little attention paid to moderate use. The excessive use of alcohol is so productive of bad effects that it would seem to need little discussion. To be sure, it has been stated that, inasmuch as alcohol in excess produces certain effects, therefore even with moderation it must produce the same effects in degree. Yet many people use alcohol moderately and secure therefrom great pleasure and delight. It is thus a serious question as to whether or not the enjoyment of the social glass must be proscribed because a large class misuse alcohol. The moderate users are frequently represented as those who "use" alcohol, as distinguished from those who "misuse" alcohol.

The excessive use of alcohol, with its attendant evils, certainly makes a man "in his cups" a menace to society. This is a strong charge against such use. Secondly, there is increasing evidence that alcohol used in excess actually injures the germ plasm, and hence affects adversely the progeny of the user. Thirdly, it is very clear that excessive indulgence in alcohol results in affecting industrial efficiency, if indeed it does not conduce to disregard of normal caution in industrial manipulations and thus actually jeopardize the lives of the man himself, of his co-workers, and of the public dependent upon his skill for proper manipulation of agencies for transportation and construction.

On these three charges, if no others, we must admit that excessive use of alcohol is highly dangerous. Among the methods used to combat this evil, that of dilution is at present receiving most attention. Alcohol in pure form is rarely consumed. The human stomach will not tolerate it. Even strong spirits, whiskey, brandy, etc., containing 50 per cent. of alcohol, are almost invariably diluted.

The pleasure and sense of euphoria derived from alcohol are not by any means limited to users of the 50 per cent. solutions, for the wine drinker has not only such satisfaction as may come from the alcohol in the wine but a delight in the palatability and bouquet of the beverage. This he obtains even though the wine contains but

9 per cent. of alcohol, and more than often he dilutes his wine with water. Finally, we must consider the enormous consumption of liquor containing still less alcohol—namely, beer, with a content of but 5 per cent., from which millions of people derive pleasure; hence, the pleasurable sensations are by no means determined exclusively by the alcohol content.

The question may be asked "Is it possible to dilute alcohol still more and yet retain the gratification derived from alcoholic beverages " A moment's reflection with regard to the amount of alcohol that can be taken by a man at one time without incipient intoxication shows that, according to laboratory experience, the equivalent of 20 to 30 cc. (1 to 1.5 ounces) of pure alcohol may be taken in this way by the average man, even on an empty stomach, without obvious signs of incipient intoxication. This is quite irrespective of whether the man is used to alcohol or not. With the prevailing tendency to dilute alcoholic liquors one would say: "Is it not possible to prepare a pleasurable beverage with an alcoholic content about one-half that of beer?" If we consider the amount of liquid necessary to take into the stomach to furnish 30 cc. (1.5 ounces) of alcohol in a diluted form, we find that it would require nearly 2 liters (2 quarts) of liquid. Although of course there are certain bacchanalian artists who can easily negotiate this volume, for the majority of individuals it would be physically impossible to hold enough liquid with a 2 per cent. content of alcohol to make a man a "menace to society" from the standpoint of obvious intoxication.

Entirely aside from the physical difficulty of absorbing enough alcohol in this dilution, we must note actual laboratory experience with dilutions as low as 2.75 per cent. In his researches Professor Miles endeavored to meet exactly this point by including a large number of tests on the effect of taking very dilute alcoholic beverages. Many of the previously mentioned findings with regard to the effect of alcohol were actually derived from experiments with 2.75 per cent. alcoholic solutions. His efforts to study alcohol and human efficiency led inexorably to the following statement: "There is no longer room for doubt in reference to the toxic action of alcoholic beverages as weak as 2.75 per cent. by weight."

No one who examines his protocols will care to take issue with him on this point. Clearly, dilution, even to 2.75 per cent., cannot solve the alcohol problem, nor can it alter our estimate of the effect

of alcohol upon human efficiency. In assessing the value of alcoholic beverages for the use of mankind, the true scientist may not disregard the obviously beneficial and seemingly legitimate phases of its effect on man. He must give recognition to the fact that used in moderation, besides being an easily digestible source of calories, it results in a great deal of gratification and pleasure to enormous numbers of people, giving them relaxation at times and again, by releasing the inhibitions, a stimulus. It is therefore a serious question whether we shall say that its moderate use is unholy, or that it transgresses any physiological laws. Undue emphasis must not be laid upon the wholly unproved habit-forming tendency of alcohol. Millions of foreigners are using alcohol regularly. They do not all—indeed no appreciable proportion of them—end their lives in drunkards' graves. When one sees the thousands, if not hundreds of thousands, of Parisians or Rhinelanders taking their wine with great regularity, and notes the relative absence of intoxication, one is quite justified in doubting the generality of the statement that alcohol has an inescapable habit-forming tendency.

With this widespread use of moderate amounts of alcohol in foreign countries, its justification in America would seem to be thoroughly established. Three important facts in American life, however, militate against this. The American use of alcohol is quite different from that of the foreigner, for the American uses his alcohol as a food accessory—that is, as an addition to his regular meal and frequently between meals—while the European for the most part replaces by the calories in acohol calories in other foods. The Bavarian peasant uses the alcohol with his coarse bread and cheese, and makes a very palatable meal. In the United States neither by virtue of the paucity of food material nor of the unpalatability of the average diet is the habitual use of alcohol justified.

Furthermore there is in the United States a tensity of life, a stimulus that leaves most Americans in a condition in which the release of normally acquired inhibitions reacts with tremendous response. The climatic conditions here are notably different from those in Europe. One is reminded of the story of Rudyard Kipling in a London Club, who is reported as discussing with Richard Harding Davis the drinking habits of the average Englishman. Kipling remarked that after his experience in America he could understand why the English drink. In England the climate is so bad and so

depressing that a man needs a half dozen cocktails a day to keep him awake, while in America the air is so surcharged with electricity that one needs only to skip across the floor to light the gas with an electric spark from the tip of one's finger.

It is not at all impossible that under the climatic conditions and methods of life existing, certainly in ante-bellum days, in France and the Rhineland and in Germany in general, moderate amounts of alcohol might be much less innocuous than when consumed under our climatic conditions.

Finally, another factor plays an important role in American life—the automobile. This discussion of the relation between alcohol and the automobile follows a careful observation of hundreds of taxicabs wending their way through the streets of Paris and in full cognizance of the fact that probably every one of their drivers had at least a pint of *vin ordinaire* in his stomach. No accidents were seen, although Paris is not without its daily quota. Notwithstanding these observations, it is true that from two to four hours after very moderate doses of alcohol practically all individuals are affected with general depression of neuromuscular processes, lessened visual acuity, and lessened eye-hand motor co-ordinations. Granting all possible functioning of autogenic re-enforcement, the driver of an automobile in the traffic of a modern American city has no business to undertake his task after drinking even these so-called "permissible amounts" of alcohol. The Massachusetts State Registrar of Motor Vehicles, Frank A. Goodwin, says: "Drive the drunkards off the road." Inflexible science says: "Moderate user, keep off! For at least four hours after a dose of alcohol formerly considered 'permissible,' you, as a motor vehicle operator, may well be considered a 'menace to society.' "

SAFFRON AND IMITATION SAFFRON.*

(Albert Noel, Assistant Trade Commissioner, Office of the Commercial Attaché, Madrid, Spain.)

Pure saffron consists of nothing but the dried stigmas of the saffron plant, an autumn-flowering species of crocus. The product saffron is used in the arts and industries as a dye or coloring matter to produce an intense bright yellow. Especially is it used as a

* From *The Spice Mill.*

harmless colorant for foodstuffs, and as a condiment for the kitchen, being one of the ingredients that give Spanish and Creole dishes their characteristic flavor. In medicine it formerly was much used as a stimulant and emenagogue. During the past twenty or thirty years it fell into disuse among physicians, but recently they have taken it up again, many of them with enthusiasm. It forms one of the ingredients of the celebrated Alibour's solution, developed in recent years as a powerful antiseptic for coccic infections.

Saffron is produced in very few parts of the world, and in relatively small quantities, which accounts for the very high price it generally commands. Spain and the Austrian Tyrol are said to be the producers of the world's best quality saffron. They are also the most important quantity producers among the regions of the globe. Spain, prior to the World War, produced annually about 120,000 Spanish pounds of 460 grams each (55,200 kilos), believed by Spanish merchants in this line to have been the maximum production of the world. The amount of Austrian production is unknown here, but Spanish authorities say that before the war it stood next to Spain's in quantity, and about the same in quality. Other producing regions are:

The region around Aquila (Italy)—very good quality, but small quantity.

The region around Pithiviers (Loiret, France)—some 4000 Spanish pounds (1840 kilos) per year of poor quality.

Turkey and Egypt—some 200 Spanish pounds each (92 kilos), which they themselves consume.

Spanish Production.

Although, as stated above, Spain's annual production amounted to 120,000 Spanish pounds before the war, it has decreased enormously since then. No one seems able to give an adequate explanation for this. Unfavorable weather conditions—persistent droughts in late summer and early autumn—are pointed to as one principal factor for the decreased production, but as nothing like such a proportional falling-off has been noted since the war in other lines of Spanish agricultural production throughout the saffron-growing districts, this explanation does not seem entirely satisfactory. Since no disease of the saffron plant has been reported, and the post-war migration of Spanish farm laborers to the towns in search of higher

wages can hardly be held responsible for the decreased production of saffron, since this is an industry affording a fairly lucrative occupation for women and girls, as well as men, one is at a loss for an explanation. However, should the Spanish saffron industry languish and practically disappear in time without any apparent cause, it would not be the first case on record of such a fate befalling one of this country's distinctive sources of wealth. The disappearance of Spanish tanned goatskins, which some centuries ago were famous throughout the world, and the inexplicable decadence of Spanish silk production, which in the sixteenth century amounted to 12,000,000 kilos and now hardly amounts to 54,000 kilos of the raw article, are examples.

The gathering and preparation of saffron for the market is a tedious occupation requiring enormous patience, like sericulture. Men, women and children go out to the fields in the early morning with large baskets in which they collect the large bluish flowers. After a piece of ground is thoroughly picked over—an operation requiring care not to bruise flowers that are budding and not yet ripe for picking—the same spot is visited again on successive mornings, and during the first days of the picking season will continue to yield each day a good quantity of flowers, this increasing for about a fortnight and then diminishing as the brief season for picking approaches its close.

After the flowers are gathered comes one of the most important operations—that of removing the long red stigmas, which are the only part of value. In the Providence of Albacete, where probably the best saffron in the world is produced, not the whole of the saffron stigma is utilized, as the flower is cut with scissors, leaving the pale base of the stigma with the stem. The red or upper part of the stigma is then separated from the petals which are thrown away. In other Spanish Provinces different methods are followed for separating the stigmas. In the Province of Toledo and the region of Aragon, where the saffron that is produced is pure but of a cheaper grade, the stigmas are not cut with scissors but are pulled out of the flower by the roots, as it were, so that although more saffron is produced from a certain quantity of flowers, it is of a generally somewhat paler color and less aromatic, as the stigmas are white and insipid at the base.

After the stigmas are removed from the flowers they are dried by artificial heat (usually a charcoal fire) in revolving cylindrical containers. Then they are ready for the market.

Regions of Spain Which Produce Saffron.

Saffron is produced in Spain by regions, as follows:

Province of Albacete.—The vicinity of three or four towns in this Province produces about 28 per cent. of the total Spanish output of saffron. The Albacete saffron is the finest in quality.

Province of Toledo.—Produces about 20 per cent. of the Spanish total. Quality very inferior to that of Albacete.

Various scattered localities throughout the region of Aragon, produce altogether about 24 per cent. of the Spanish total. Quality inferior like that of Toledo.

Province of Cuenca.—Produces about 16 per cent. of Spain's total. Quality quite good; about midway between that of Albacete and that of Toledo.

Provinces of Ciudad Real and Valencia.—These produce the rest of the total Spanish output. Quality variable; mostly inferior.

Present Production and Prices.

The figure given above for Spanish production of saffron prior to the war cannot by any means be used as a basis for calculating what this year's production or the production of immediately succeeding years will be. Production has been declining of recent years for a multiplicity of causes, some of which are vague and hard to explain. The 1923 production amounted to only 35,000 Spanish pounds of 460 grams, but this year's production is not expected to be any greater, although some efforts have been put forth to make it so. These efforts were offset by the prolonged parching drought that made itself felt throughout nearly all Spain, drying up vegetation of all kinds, including many saffron plants that otherwise might have been expected to bloom this fall.

Prices of pure Spanish saffron have, since the war, undergone an even greater change than production. In 1918 the best Albacete saffron could be obtained from the grower for forty pesetas the pound (460 grams). Toledo and similar inferior grades of saffron was worth twenty-five pesetas. Present prices vary from 280 pesetas a pound (460 grams) for the best Albacete, to 260 pesetas for

Toledo. The present tendency of prices is downward. It is believed that when this fall's crop is ready for export, Albacete saffron will be obtainable for 200 pesetas a pound of 460 grams. Other classes will be in proportion. Such a price as this is more nearly normal, the present high quotations being due to the exhaustion of stocks throughout this country.

Export Markets and Export Methods.

The gathering and preparation of saffron for the market is not in the hands of any large companies or syndicates. The growers and preparers of saffron are generally people of modest means, and they sell direct to the Spanish exporters. The exporters themselves earn a very small amount on their transactions, not more than two or three pesetas per Spanish pound.

There is no definitely established system quoting saffron for export. In Spain it is sold per Spanish pound of 460 grams, but quotations to the various export markets are made, as a rule, in pesetas as per the weights current in those markets.

Export markets for saffron have changed since the war. Some countries which formerly took large quantities of the product now show slight interest in it, while others that formerly never called for it are now importers. Among these latter is Germany, which last took ten cases of sixty and seventy kilos each, and in the two preceding years considerable quantities, all of which were shipped to Frankfort. Spanish exporters cannot understand what use the Germans can make of this saffron, since it is not employed for the condimentation of German dishes, and the Germans would hardly use it for a dyestuff, strong as they are in the manufacture of synthetic colors. Other export markets which now are of first importance are Cuba and Argentina, where it is used in cooking. Other Latin-American countries are also good purchasers, and small amounts are shipped all over the world.

Adulterated Saffron.

In view of the high price of saffron, the temptation to adulterate it is very strong. In Spain, probably the greatest consumer of saffron among all the countries of the world, the great majority of the saffron on sale in the grocery stores and "droguerias" (establish-

ments where drugs, chemicals, coloring materials, etc., are sold in bulk) is adulterated. The adulterated saffron is, for the most part, bought and sold knowingly, as it is not very difficult to detect if the adulteration is heavy.

Adulteration practically always consists of impregnating some of the saffron stigmas with heavy, tasteless, and harmless mineral salts, in order to make it weigh more. For example, five pounds of pure saffron are to be adulterated. The usual way is not to impregnate with mineral salts the whole mass, but to take out, say, one pound or two pounds, impregnate there, and mix them with the pure. Experts say that it is very easy to make double the weight of saffron by impregnation with salts, and to the senses the saffron appears exactly the same, except for the increased weight. The saffron stigmas are very absorbent, as upon drying over the charcoal fire the weight of the stigmas is reduced to one-fifth the weight they had before drying.

The common adulterations of saffron, dependent upon the increased weight of mineral salts, can always be detected by chemical analysis. A simpler but less conclusive way of detection is to burn the stigmas in the flame of a match or an alcohol lamp. Stigmas impregnated with mineral salts curl up and resist burning, while those that are impregnated burn readily with a bright flame. The difference is almost the same as between burning woolen and cotton threads, the woolen threads corresponding to the adulterated saffron and the cotton to the pure. The stigmas, or fibres, should be burned one by one, and a decision should be withheld until at least twenty-five or thirty have been tried in the flame. The practice followed by many Spanish grocers of catching a large pinch of the fibers and testing with them all in a bunch is not advisable, as if there are only a small proportion of impregnated fibers they will not be detected.

Apparently this, the commonest form of adulteration, is not in the least prejudicial to the health. Adulterated saffron, euphemistically called "Azafran cargado," is sold as such, and it has its demand, owing to the higher price of the pure. There is a great demand for a very low grade of adulterated Spanish saffron in British India, to which country it is shipped in such an impure state that its price is only eighty pesetas the pound of 460 grams.

Imitation Saffron.

Naturally, hundreds of ways have been resorted to in order to turn out imitation saffron. There are said to be in Spain at the present time between fifty and sixty concerns (mostly small) which produce imitation saffron. This may consist of stigmas, pistils or even petals of harmless flowers, other than saffron flowers (a certain thistle is said to answer the purpose very well), impregnated with a decoction of real saffron to give it taste and aroma, and colored red with aniline or other dyes to perfect its resemblance to real saffron. Such imitations as this are costly, however, if much real saffron is used to give them taste and aroma, and cheap hotels and boarding-houses are large consumers of imitation saffron, which has hardly a trace of the real article in its composition. A test for imitation saffron, apart from its weaker taste and aroma, or almost lack of both, is to moisten the red fibers and rub them gently on a piece of white paper. Imitation saffron will almost always give the paper a stain that is not the characteristic yellow of real saffron, but a more or less burnt orange or reddish tint. Another severer test is to cook rice with it, not adding any tomato, ground pimienta (paprika) or anything else that has a color of its own. If the rice takes on a reddish tinge, as though flavored also with pimienta, the saffron is imitation. Imitation saffron sells as cheaply as fifteen pesetas a kilo.

SOLID EXTRACTS

Less than a half pound, between 200 and 220 grams, of radium has been produced in the world since Madam Curie discovered this precious element in 1898.

Small as this quantity of material is, it represents an almost unbelievable amount of work and expense in the refining of the radium and at the present price represents a total value of $15,000,000. Its commercial production entails the handling of enormous masses of minerals. When carnotite from southwestern Colorado is used as the source, more than 500 tons of ore must be handled to yield one gram of radium. In this process a like tonnage of chemicals, a thousand tons of coal, and upwards of ten thousand tons of treated or distilled water are used—the final product being pure radium bromide, a white powder resembling powdered sugar, having a bulk sufficient to half fill an ordinary thimble.

By adding aluminum powder to paint, its life can be lengthened, its

resistence to moisture increased, and its value as a protector against light heightened. A perfect film of aluminum paint is said to allow no light at all to penetrate.

A new kind of tarnish-resisting silver has been developed by a British silver manufacturing company. The material, which is 92½ per cent. silver alloy, has been put to practical test by the manufacture of articles from it, and the results have been reported to the Silver Trade Technical Society.

The new alloy is said to stand up to the heat necessary for soldering, and to keep shape while being heated. It will bear more heat than standard silver, and will allow of a considerable amount of manipulation without developing any defect.

Housewives are following the experiments with interest in the hope that egg and fruit stained silverware will soon be problems of the past.

Of seventy deaths due to accidental poisoning during 1924 among children between the ages of one and four years insured in the industrial department of the Metropolitan Life Insurance Company, twenty-four were due to strychnine. This was four times as many as the number due to lye and other alkalies, which came second in numerical importance. "Cathartic and tonic pills, containing strychnine and left within the reach of children, were one of the most important sources of poisoning," the company stated.

Experiments just completed by E. Brown, of the United States Department of Agriculture's Seed Laboratory, show that of one hundred species of seeds buried for twenty years, weed seed showed the highest per cent. of germination when planted.

According to Mr. Brown, however, twenty years is as but a night to a seed as numbers of successful experiments have been made in germinating seed which has been buried forty years. Reports from Japanese investigators in Manchuria indicate that seed buried for about four hundred years has been grown successfully.

How long seed can live is not definitely known, but it is known that seed taken from Egyptian and prehistoric tombs will not grow. Mr. Brown characterized as impossible the often recurring stories of wheat from Egyptian tombs that has sprouted and borne fruitfully after several thousands of years of storage.

While the medical solons, in convention assembled, reassure themselves and a few others that alcohol is an essential therapeutic agent, it seems quite appropriate to read in "American Medicine" that water, pure distilled water, has given some good results as a medicine. Intravenous injections of distilled water in doses varying from ½ to 5 cc., adapted according to circumstances, have been found to give great relief in many cases of hay-fever, neuralgia, rheumatism, pertussis, asthma and sciatica. Sterile fresh, triple distilled water, chosen as representing water practically free from all impurities was employed.

The United States Public Health Service has announced results of experiments which prove that severe

cases of human pellagra can be either prevented or cured by means of dried yeast.

It is only in severe cases of pellagra that such dried yeast treatment is necessary as in milder cases careful feeding is sufficient. Brewers' yeast has been used so far, but the experimenters believe that bakers' yeast will work as well.

Seeking for a siren lure for the scourge of New Jersey and Pennsylvania orchards and gardens, the Japanese bettle, the Bureau of Entomology, United States Department of Agriculture, has discovered that geraniol sprayed on plants brings every Japanese beetle for a long distance to windward to the tree. They hover around it, inhaling the odor with apparent delight.

The beetles do not eat the geraniol, but recent experiments have shown that they enjoy the taste of lead oleate. Previously it has not been possible to persuade them to eat arsenate of lead, because some instinct seems to warn them it is poisonous. But when this is mixed with lead oleate the taste of the arsenic and lead is disguised.

The smallest snail will withstand more strychnine than an adult man. Many of the stronger cardiac poisons have no action whatever on insects. The rabbit can take more morphine than can a man fifty times the animal's weight. Doses of lead, nicotine, etc., sufficient to poison man fatally do not injure the goat. Amygdalin does not affect dogs, but it kills rabbits. The hedgehog takes with apparent enjoyment a dose of cantharides that will kill several persons under excruciating pains. Whereas, the frog is extraordinarily susceptible to the digitalis poisons, they have no affect upon the toad.

MEDICAL AND PHARMACEUTICAL NOTES

Organic Protein and Colloidal Silver Compounds. IV. Deterioration of Solutions on Keeping. T. Sollmann and J. D. Pilcher, Cleveland.—Sollmann and Pilcher have found that solutions of the colloidal silver compounds show progressive changes of antiseptic efficiency on keeping. Protargol solutions (and presumably others of the same type) become poorer in ionic silver, and therefore less efficient; but even in a year the change would not be of much clinical importance. Argyrol and silvol (and presumably others of the type), become richer in silver ions, and therefore more antiseptic, but also more irritant. The changes start rapidly, so that a week might suffice to modify the clinical response.—*Jour. Lab. & Clin. Med. through Jour. Amer. Med. Assoc.*

California Hay-Fever Blamed on Bermuda Grass.—Devil-grass, the curse of California lawns, has been indicted for misdemeanor on a new count. Hay-fever is the trouble this time, according to Dr. George Piness of Los Angeles, Cal., whose extensive researches on diseases from protein irritation lead to the conclusion that Bermuda grass—or "devil-grass," is possibly the worst hay-fever offender in the State. In this investigation the human skin is tested with a liquid extract of pollen in a manner suggestive of vaccination.

California fortunately does not harbor the notorious eastern ragweed, the curse of so many eastern hay-fever victims, and for such special cases a haven of refuge. However, a different class of people develop a sensitiveness to the pollen of Bermuda grass. The irritation rises to a climax when the family lawn-mower chops and throws up the pollen-laden flowering heads of the grass. Many unwitting victims sneeze their way through such experiences, blaming dust, germs, colds or bad luck in general.

The California resident likes to have a year-round green lawn, perfectly attainable with Kentucky blue grass, which will stand the mild frosts of a western winter. Bermuda grass, however, invariably seeds itself into such a lawn, chokes out the Kentucky grass by a vigorous summer invasive growth, and then dies down to a sickly brown with the first touch of cold weather. So far it seems to be a fine example of the ill wind that blows nobody good.

Nutrition of Air-Plants.—Residents and visitors to the warmer parts of the earth are familiar with the epiphytic plant, especially the species of *Tillandsia*, including the "Long Moss" of our Southern States. As these plants often grow on telegraph wires and other supports which can yield no direct nourishment, it has been a problem as to how the plants obtain food. R. Dubois made to the French Academy of Sciences in April of this year, a communication concerning the nutritive sources of specimens of *To dianthoides,* a Uruguay species, which he noted growing for fifteen years on an iron wire. It has flowered each year. It has no water reservoir in it structure, does not secrete a gummy matter on its leaves, possesses no supply of proteolytic or amylolitic enzyms, and does not digest the plants or insects which happen to collect on it. Minute projections on the surface of the plant (usually termed "scales" by

botanists) contain inorganic materials and also numerous minute vegetable organisms, including mushrooms, belonging to the Hyphomycetes. As these are not considered to be parasitic, Dubois regards the condition as one of symbiosis, analogous to the well-known symbiosis of the legumes. These "air-plants," therefore, should not be considered carnivorous. In this connection it may be noted that it has been shown that many orchids are symbiotic. This note is taken from an abstract of the paper in *Rep. d. Pharmacie* [3], 1925, *36*, 156. Many years ago, Professor König, of the University of Pennsylvania, reported at a meeting of the Academy of Natural Sciences the analyses of a number of specimens of the *Tillandsia* of Florida, showing a notable amount of ash. It must be borne in mind, however, that as a rule leaves are higher in ash than most other plant structures. This fact is familiarly indicated in the ash of the tobacco leaf. H. L.

English Plantain—New Source of Hay-Fever.—English plantain, which, like the English sparrow, has become an agricultural pest in the United States, is now accused of making life miserable for a good many hay-fever victims. Dr. Harry S. Bernton, special expert of the United States Public Health Service, who makes the charge, reports that this weed has hitherto received only passing attention from American investigators of hay-fever causes.

In one case which he describes, a patient had suffered from hay-fever for thirteen years. He had been tested with pollen extracts from different grasses in the hope of gaining immunization from the disease, but apparently none of the grasses was the irritating agent. Dr. Bernton made cutaneous and intra-cutaneous tests with pollen from English plantain, and the itching, swelling, and reddening of the skin showed that the irritating cause had been found. After treatment with the pollen extract, the patient was left 98 per cent. free of the disease.

English plantain has been recognized as a hay-fever plant of the first rank in Washington and Oregon, says Dr. Bernton, but in most sections of the country its possible importance has been overlooked. In the region of the District of Columbia, 16 per cent. of a series of patients subject to the vernal type of hay-fever were found to be sensitive to the plantain pollen.

The United States Department of Agriculture says: "The English plantain, like the English sparrow, seems to stick closely to the thickly populated sections. It is found abundantly along streets in the outskirts of cities, on vacant lots and dump heaps, producing pollen in great abundance from about May 10 to August 1."

NEWS ITEMS AND PERSONAL NOTES

The Visit of Sir William Glyn Jones.—Sir William Glyn Jones, the famous English pharmacist-politician, and his party visited Philadelphia the latter part of May and were entertained during their stay by the several drug interests of the city. A group of persons representing the American Pharmaceutical Association, the Philadelphia Association of Retail Druggists and the College sat to dinner with the distinguished guests at the Bellevue-Stratford Hotel and afterwards, at the Auditorium of the College, augmented a large audience which had gathered to hear Sir Glyn Jones present his admirable story of the P. A. T. A. in Great Britain. No one who listened could but admit that the plan of price protection fostered by the then small town apothecary, grew up healthfully into a sound substantial performance—and no one, in the judgment of the writer, could have been better fitted than Sir Glyn Jones mentally and tempermentally, to have brought this great undertaking to its successful consummation.

The transplantation of this idea from British soil to that of Canada is being carefully observed on this side of the boundary and its growth will be as equally carefully watched.

Sir Glyn Jones was greatly interested in the progress of pharmacy in the States and if our judgment is correct his conception of American pharmacy has undergone a mutation since his visit to Philadelphia.

Honoring the New President-Elect of the American Pharmaceutical Association.—Lucius L. Walton, "in whose honor this testimonial dinner is given by his friends and coworkers in pharmacy and in medicine"—so reads the inscription on the program for this event, tendered to Lucius L. Walton, at the Hotel

Lycoming, Williamsport, evening of May 20. Dean Charles H. LaWall, an ex-President of the Association; Dr. John P. Harley, President of the Lycoming County Medical Society; O. W. Osterlund, of Philadelphia; Dr. Harry Donaldson, President of the staff of the Williamsport Hospital, and many other speakers, voiced their appreciation of Dr. Walton's inestimable and loyal services in the several fields of his useful activities.

This Journal adds its good wishes and expresses its belief that the American Pharmaceutical Association in electing Dr. Walton to its highest office honored itself in so honoring one of its most earnest and loyal members.

Lewis C. Hopp, Deceased.—Lewis C. Hopp, a nationally known pharmacist, is dead at the age of sixty-eight. Mr. Hopp was born in Cleveland, and for years he was active and prominent in local and national pharmaceutical affairs. He was one of the founders of the Ohio State Association in 1879, and served both as President and Secretary. He was one of the founders of the Cleveland School of Pharmacy, and its President for years. During 1903 he was President of the American Pharmaceutical Association, and he was a member of the present Revision Committee of the U. S. P. Mr. Hopp was a graduate of the Philadelphia College of Pharmacy and Science, which institution later conferred upon him the degree of Master in Pharmacy, *Honoris Causa*.

A New Way to Pay Old Debts.—The "Bulletin of Pharmacy of the South-East," which is the official publication of a federation of societies in southeast France, the territory stretching to the shadows of the Pyrenees, reports in a recent issue (1925, *29*, 584) a novel method of securing information for the purpose of levying personal tax. An official of the tax department visited a pharmacist in Carcassonne, requesting to be allowed to examine the prescription files, with a view to securing some statistics. The pharmacist demurred, saying that these records were confidential, but the official replied that he was also put under confidence. He was allowed to examine the files, which he did for two hours. It appeared later that his object was to find the number of prescriptions written by a certain physician who was receiving some allowance for war service. The

Government wanted to know something about the extent of his practise with a view, presumably, of cutting down his allowance if his income justified this. Protest has been made by pharmacists against this practise, but it is not impossible that such a system of inquisition may extend even to other nations.

An evil that may result if the inquisitory system is largely applied is that physicians may be induced, with a view of concealing the extent of their practise, to direct patients to buy proprietary medicines, which can be obtained without a prescription, indeed, in many cases not even of a pharmacist. H. L.

BOOK REVIEWS

THE STORY OF EARLY CHEMISTRY. By John Maxson Stillman, Late Professor Emeritus of Chemistry, Stanford University. Octavo. 566 pages. Cloth, $4. D. Appleton & Co., New York.

Shortly before the first proofs of this book were published, its author passed quietly away at his home at Stanford University, after only a few hours of acute illness. A few biographical data might therefore be opportune. Professor Stillman was born in New York on April 14, 1852. In 1874 he was graduated from the University of California, to which, after two years of study at Würzburg and Strassburg, he returned as instructor in chemistry. In 1885 his Alma Mater granted him the degree of Ph. D., and later, in 1916, the one LL. D. After some years of service at University of California, he accepted a position as chief chemist at the Boston Sugar Refinery, which he held for ten years, when he became the first executive head of the newly founded Leland Stanford Junior University, where he was continuously active until 1917, when he retired as professor emeritus. He died on December 13, 1923.

The need of a rewriting of the history of early chemistry has made itself felt—a need met by the present volume. Professor Stillman in it has told the story of chemical knowledge and science from the earliest time to the close of the eighteenth century, in a connected and systematic way, emphasizing throughout such discoveries and speculations as have made a decided impress on the growth of the science. The author's aim has been to make the book readable for

those whose knowledge of the science is not profound, as well as for the professional chemists who need such a presentation of the early development of their science. It is a fascinating story, this, of man's groping toward exact science from 'way back among the early Eastern philosophers, down through the Greeks, to the medieval alchemists, and such later thinkers and chemists as Roger Bacon, Geber, Paracelsus, and Agricola, to the chemical revolution of Lavoisier.

The referee had the pleasure to review Professor Stillman's earlier historical book, "Paracelsus," and is thankful for the opportunity to review this volume. This work which in an interesting manner tells the story of the development of chemical knowledge and science from the earliest known beginnings to the close of the eighteenth century and the downfall of the phlogiston theory, should be in the hands of all interested in chemistry. Pharmacists will also do well to acquire this book.

OTTO RAUBENHEIMER, PH. M.

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